CORPS OF ENGINEERS, U. S. ARMY

MISSISSIPPI RIVER COMMISSION

FLOOD PROTECTION PLANS FOR

BRADY, TEXAS

MODEL INVESTIGATION

TECHNICAL MEMORANDUM NO. 2-270

WATERWAYS EXPERIMENT STATION

VICKSBURG, MISSISSIPPI

MRC-WES-125-MARCH 49

MARCH 1949

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **MAR 1949**	2. REPORT TYPE	3. DATES COVERED **00-00-1949 to 00-00-1949**
4. TITLE AND SUBTITLE **Flood Protection Plans for Brady, Texas: Model Investigation**		5a. CONTRACT NUMBER
		5b. GRANT NUMBER
		5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)		5d. PROJECT NUMBER
		5e. TASK NUMBER
		5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **U.S. Army Corps of Engineers,Waterway Experiment Station,3903 Halls Ferry Road,Vicksburg,MS,39180**		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S)
		11. SPONSOR/MONITOR'S REPORT NUMBER(S)
12. DISTRIBUTION/AVAILABILITY STATEMENT **Approved for public release; distribution unlimited**		
13. SUPPLEMENTARY NOTES		
14. ABSTRACT		
15. SUBJECT TERMS		

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a REPORT **unclassified**	b ABSTRACT **unclassified**	c THIS PAGE **unclassified**	**Same as Report (SAR)**	**72**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

CONTENTS

SUMMARY

A model study of proposed plans for the protection of the city of Brady, Texas, from Brady Creek floods was conducted at the Waterways Experiment Station for the Galveston District, CE, during the period October 1945 to September 1946.

Tests were conducted on a fixed-bed model with scale ratios of 1:150 horizontally and 1:100 vertically. The results of the model study indicated that: (a) the project levee grade should be raised 1.0 to 1.5 ft between levee stations 35+00 and 69+00; (b) the low steel of the Highway 87 bridge should be raised 0.8 ft to give a clearance of 1.0 ft; (c) bridge structures and bank riprap should be examined in the light of the magnitude of observed velocities; and (d) consideration should be given to modification of the south-bank approach to the Gulf, Colorado and Santa Fe Railroad bridge as developed in the model tests.

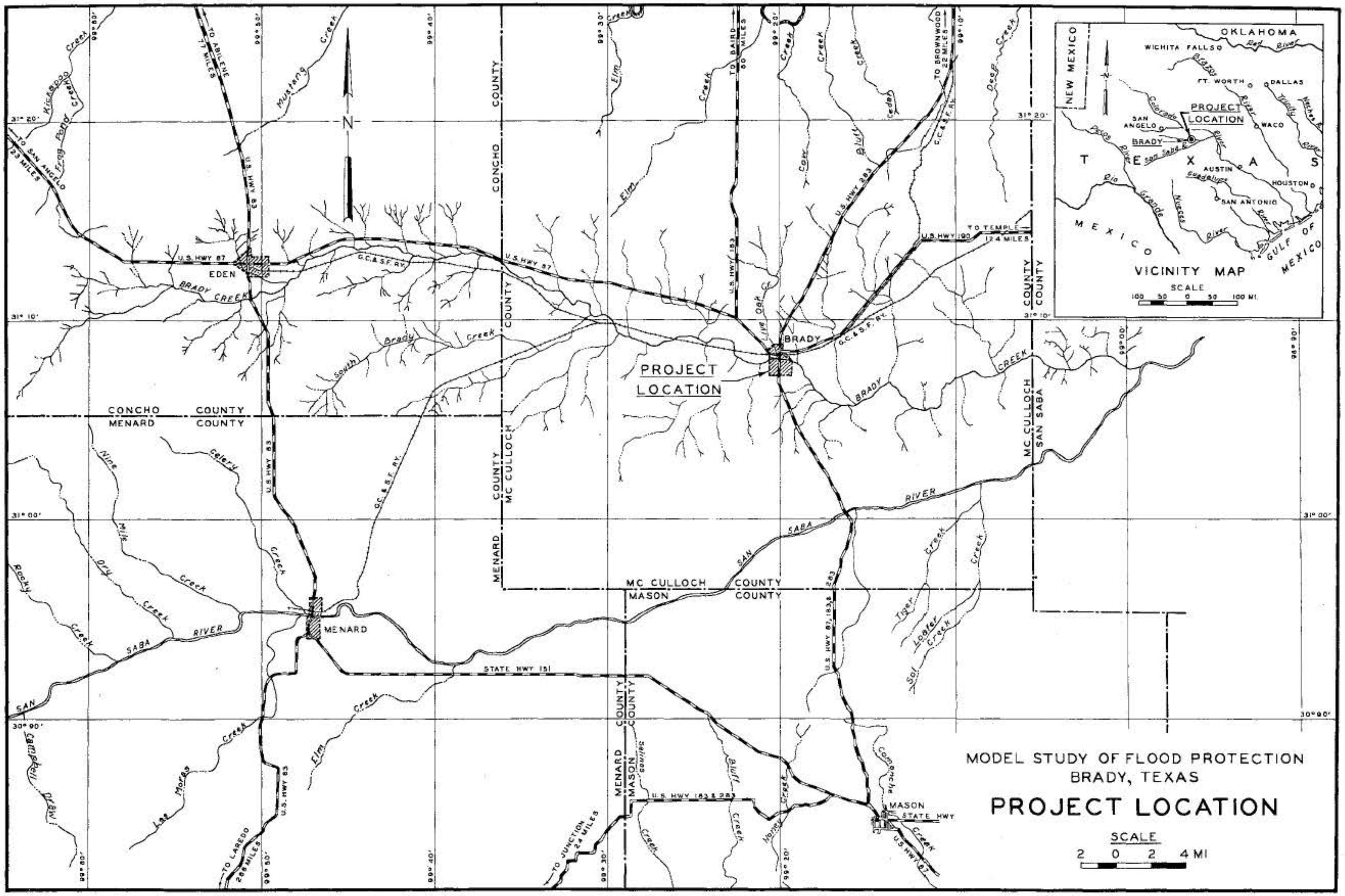


Fig. 1. Vicinity map

FLOOD-PROTECTION PLANS FOR BRADY, TEXAS

Model Investigation

PART I: INTRODUCTION

The Problem and Its Locale*

1. This memorandum constitutes a final comprehensive report on the results of a series of model tests conducted for the purpose of either verifying or modifying the basic design assumptions relative to an improvement project planned for protecting Brady, Texas, from floods on Brady Creek.

2. Brady Creek rises in northern Menard and southern Concho counties in central Texas (see fig. 1). It flows for approximately 85 miles, generally in an easterly direction, to its confluence with the San Saba River, a tributary of the Colorado River. The creek drains an 810-square-mile area of gently rolling to rough country of which 578 square miles are above the city of Brady. The average fall in the vicinity of Brady, which is 29 miles above the mouth, is about eight feet per mile.

3. The city of Brady is located 154 miles northwest of Austin, Texas. It is the county seat and largest commercial center in the Brady Creek watershed, having a population of 5,002 persons in 1940. The city lies along both sides of the creek -- the major portion, including the

---

* Information on the prototype was obtained from the definite project report on flood protection at Brady, Texas, prepared by the Galveston District, CE.

industrial and business districts, being situated on the right or south bank. The right bank is comparatively low, averaging about 23 ft above the stream bed. From the right bank the land slopes gently upward for a distance of about 1200 ft and then rises abruptly. The principal portion of the business district is located on this gently sloping area and is subject to flooding by Brady Creek. The city has constructed a rubble masonry floodwall and earthen levee along the right bank in an effort to protect the area from floods. These existing works provide protection against flows up to about 48,000 cfs. Approximately 264 acres of the city, including the major portion of the business district, were inundated by the maximum known flood. This flood occurred on 23 July 1938, and had a peak discharge of approximately 86,000 cfs. The left or north bank of Brady Creek through the city is relatively high, averaging approximately 30 ft above the stream bed. From the left bank the land rises rapidly toward the north and the area subject to flooding is very small.

4. One railroad bridge and two highway bridges span the creek at Brady. The Gulf, Colorado and Santa Fe Railroad bridge is located at the eastern or downstream limit of the city. The U.S. Highway 190 bridge crosses the creek at the center of the city, and the U.S. Highway 87 bridge crosses near the western or upstream limit of the city.

The Definite Project Plan

The design discharge

5. In selecting a flow to be used in the design of the proposed flood-protection works at Brady, an investigation was made by the

Galveston District, CE, of all the major storms that had occurred in the general region of Brady in which rainfall was sufficient to create critical flood conditions on Brady Creek at Brady. It was found that the greatest flood peak which could be produced by transposing any of the experienced storms over Brady Creek above Brady would result from the storm which centered at Broome Ranch during the 12-hr period from 9:00 p.m. on 16 September to 9:00 a.m. on 17 September 1936. The computed peak discharge which would result at Brady from such a storm is 270,000 cfs.

6. To provide complete protection for the city against this flood would be very expensive. It would require the objectionable elevation of bridges and the protective works would encroach unreasonably upon the protected area. Since the probability of the occurrence of this flood is remote, and since, on the other hand, even greater floods are possible, it was considered impracticable to provide protection against floods of this magnitude. Therefore, in order to provide protection which can be economically justified, the peak discharge of 206,000 cfs recommended in the project document has been adopted as the design discharge.

The improvement plan

7. The general plan provides for the protection of that portion of the city of Brady located on the right bank of Brady Creek by enlarging the existing channel and constructing a levee, thereby forming an improved floodway with sufficient capacity to pass the design discharge of 206,000 cfs with a minimum freeboard of 1 ft.

8. The definite project plan comprises the following principal features:

a. An improved channel in Brady Creek through Brady, 8800 ft long and unlined except for small riprapped areas at the bridges.

b. Protective works on the right bank of Brady Creek consisting of an earthen levee.

c. Relocation of two highway bridges, one railroad bridge, public utilities, and other structures.

d. A lift station to lift sewage over the levee during periods of high flow in the creek.

e. Nine concrete culverts through the levee for discharge of interior drainage.

9. Since the model study was concerned only with features a and b above, a detailed description of only these features is presented below:

a. Channel. The proposed channel would extend from station 8+00, 1200 ft downstream from the existing Gulf, Colorado and Santa Fe Railroad bridge, to station 96+00, 1320 ft upstream from the existing U.S. Highway 87 bridge, a total length of 8800 ft (plate 1). It would have side slopes of 1 on 3 and a bottom width of 200 ft for the entire length except for short transition sections at both ends, where the channel would narrow to normal creek-bed width. The proposed channel would be unlined except at the bridges, where it would be riprapped for a distance of 200 ft. However, riprap would be omitted where rock is exposed. The riprap would be 2 ft in thickness laid on a 12-in. gravel or crushed stone blanket.

b. Levee. The proposed levee would begin on the right bank of Brady Creek, at station -11+24, at the center line of the existing Gulf, Colorado and Santa Fe Railroad, and extend in a northerly direction along the proposed railroad embankment to Brady Creek; thence upstream on the right bank of the creek to its junction with the floodwall. The levee would then extend from the upstream end of the floodwall to high ground, approximately 1070 ft upstream from U.S. Highway 87. The levee would be a compacted, impervious, earthen structure having a total length of 7670 ft, a crown width of 14 ft, and side slopes of 1 on 2-1/2 on the creek side and 1 on 2 on the landside, except as shown on plate 1. The average height above existing ground would be 21 ft, with a minimum freeboard of 1 ft above the design water surface.

Need and Authority for Model Study

10. Because of the radical changes which would be effected in the Brady Creek channel by the definite project plan, it was thought desirable to verify hydraulic design computations by model analyses. Accordingly, authorization for a model study of the problem area was requested by the Galveston District, CE, and was granted by the Chief of Engineers 10 September 1945. The study was conducted at the Waterways Experiment Station during the period October 1945 to September 1946.

Liaison and Personnel

11. During the course of the investigation, close liaison was maintained between the Waterways Experiment Station and the Galveston District. This liaison was effected primarily by collaboration of the representatives of the two offices in the progressive development and testing of the various features of the flood-control plan. Preliminary results of each test were furnished the District Engineer during the testing period. The data presented in this report supersede all preliminary results previously reported.

12. Active in liaison and advisory capacities as representatives of the Galveston District during the study were Messrs. M. A. Dillingham, W. A. Wood, J. J. Dillard, and J.I.C. Tamborino, engineers. Engineers of the Waterways Experiment Station directly connected with the study were Messrs. G. B. Fenwick, E. B. Lipscomb, W. W. Geddings and J.A.C. Wood.

PART II: THE MODEL

Purpose of Model Study

13. The general purpose of the model study was to verify and supplement hydraulic design computations for the proposed Brady Creek improvement channel. Of special interest were the following:

- a. Verification of the computed water-surface profiles.
- b. Verification of the design levee grade.
- c. Determination of the magnitude and distribution of velocities at selected locations throughout the area under improvement.
- d. Determination of any undesirable flow conditions within the improvement, particularly in the vicinity of the bridges and at the confluence of Live Oak Creek and Brady Creek.
- e. Recommendations as to design modifications indicated by the model study.

Description

14. Reproduced in the Brady Creek model were 625 ft of the natural Brady Creek channel immediately above the improvement, the full 8800-ft length of improved channel, and 7700 ft of the natural channel immediately below the improvement. Reproduction of the upper 625 ft of the natural channel was necessary to obtain natural flow conditions approaching the critical section, and reproduction of the lower 7700 ft of natural channel was necessary to provide correct tailwater conditions. Since the proposed flood-protection project was designed to provide complete protection for the city of Brady from floods up to 206,000 cfs, and since the improved channel would be a radical departure from existing

conditions, the usual testing procedure of first establishing natural conditions in the model was not considered applicable. Instead, the proposed improvement conditions were incorporated in the model during its construction, with surfaces roughened to reproduce design roughness factors.

15. The model was of the fixed-bed type, all channel and overbank areas being molded in concrete (fig. 2). The reproduction of natural conditions in the model was in accordance with configurations shown on topographic maps supplied by the Galveston District, CE. Details for construction of the improved section were taken from appropriate sheets of two sets of plans bearing the District Office file No. Colo. 601-65 and Colo. 601-70. The relocated Gulf, Colorado and Santa Fe Railroad bridge, the relocated U.S. Highway 87 bridge, and the raised U.S.

Fig. 2. Upstream view of Brady Creek model

Highway 190 bridge were also simulated in the model.

Scale ratios

16. The model was constructed to linear scale ratios, model to prototype, of 1:150 horizontally and 1:100 vertically. On the basis of the Froudian relationships for the adopted linear scales, other significant model-to-prototype ratios were as follow:

Velocity	1:10
Time	1:15
Discharge	1:150,000
Roughness (Manning's "n")	1:1.78 (an average value)

Appurtenances

17. Means were provided in the model for the introduction and measurement of any desired flows in Brady Creek and Live Oak Creek, a small tributary stream entering Brady Creek from the north a short distance downstream from the upper end of the improvement. Brady Creek flow was measured by means of a right-angle V-notched weir and Live Oak Creek flow was measured by means of a Van Leer weir. A tailgate was provided to control tailwater elevations at the lower end of the model.

18. Water-surface elevations throughout the model were determined by means of twenty-seven piezometer-type gages located along the center line of the channel and at strategic points on the overbank (plate 1). Determination of water-surface elevations along the proposed right bank levee were made at 500-ft (prototype) intervals by means of portable point gages.

19. Velocity measurements were made in the model at selected ranges (plate 1) by means of a pitot tube. Surface current directions were traced by means of confetti sprinkled on the water; and currents

below the surface were defined by the introduction of dye into the path of flow. Photographic records were made of current directions demonstrated in this manner.

Adjustment

20. Prior to undertaking a detailed study of the improvement plan, the Brady Creek model was subjected to a series of adjustment tests. The model adjustment was divided into two phases consisting of: (1) adjusting the roughness of the 625-ft reach of natural Brady Creek channel above the improvement and the 7700-ft reach of natural channel below the improvement as necessary to bring about model reproductions of the only natural flood flows for which data were available; and (2) adjusting the roughness in the improved reach as required to simulate the design roughness coefficient of the prototype.

21. Adjustment of the natural reaches at either end of the improved reach was accomplished empirically by introducing into the model a flow of 86,000 cfs (peak discharge of 23 July 1938 prototype flood), holding the water surface at the lower end of the reaches to the corresponding prototype elevation, and then adjusting the model water-surface elevations in the natural reaches until they agreed with corresponding water-surface elevations observed at the crest of the 23 July 1938 prototype flood. Adjustment of the model water-surface elevations was accomplished by the trial-and-error application of stucco and wire roughness to simulate, respectively, the natural surface roughness and superimposed roughness such as underbrush and trees.

22. Once a satisfactory adjustment of the two natural reaches of

Brady Creek had been accomplished, adjustment of the roughness in the improved reach as required to simulate to scale the design roughness coefficients of the prototype was undertaken. Prototype coefficients of roughness ("n" in Manning's formula) used in the adjustment of the improved reach were supplied by the Galveston District, CE. These coefficients were: 0.030 for riprapped surfaces, 0.030 for the excavated channel, and 0.50 for the overbank adjacent to the excavated channel. To model scale, these coefficients would be: 0.017, 0.017 and 0.028, respectively. The types of model roughness required to simulate these coefficients were determined in supplementary model tests and then reproduced in the Brady Creek model.

PART III: NARRATIVE OF TESTS

23. A conference between representatives of the Galveston District Office and the Waterways Experiment Station was held at the Waterways Experiment Station 28 March 1946 to establish a schedule of tests for the model study. It was decided in this conference that the project improvement plan should be studied under the action of constant-stage flood flows of two magnitudes: the natural flood of 1938, which had a peak discharge of 86,000 cfs; and the theoretical design flood, which has a peak discharge of 206,000 cfs. It was decided further that tests should be conducted to obtain water-surface profiles along the center line of the improved channel and along the levee, to determine velocities at selected locations in the improved reach, and to determine and attempt to rectify any undesirable flow conditions, particularly in the vicinity of the bridges and at the mouth of Live Oak Creek.

Test 1 -- Original Design

Description

24. The plan for the improvement of Brady Creek investigated in test 1 was the original design prepared by the Galveston District, CE. The plan as installed in the model for test 1 is shown on plate 1. A detailed description of the plan is presented in paragraphs 8 and 9.

Results

25. Water-surface profiles. Water-surface profiles along the center line of the improved channel and along the levee are shown on plates 2 and 3, respectively, and tabulations of the data are presented

in tables 1 and 2, respectively. Also presented in table 1 are water-surface elevations computed by the Galveston District. It will be noted that two columns of computed elevations are shown. In the computation of elevations shown in column "A", velocity head changes were considered, whereas for column "B" velocity head changes were neglected. These data reveal that water-surface elevations obtained in the model for the portion of Brady Creek below the improvement were in substantial agreement with the computed elevations shown in both columns. Water-surface profile obtained in the model along the center line of the improved channel was from 1.5 to 3.0 ft higher than the computed elevations shown in column "A", but was in fairly close agreement with the computed elevations in column "B". In view of the fact that the model automatically reflects velocity head changes which will occur in the prototype channel and since elevations observed in the model agreed closely with elevations computed under similar conditions, it would appear that design of the improvement plan should be based on elevations determined either by model analysis or by computation based on velocity head changes. Indicated bridge clearances for the 206,000 cfs flow were approximately 1.9 ft at the railroad bridge, 0.9 ft at Highway 190 bridge, and 0.2 ft at Highway 87 bridge. Table 2 and plate 3 show that the average water-surface elevations obtained in the model at 500-ft intervals along the levee for the flow of 206,000 cfs indicated the desired 1-ft freeboard between levee stations 0+00 and 35+00. Freeboard deficiencies were indicated between levee stations 35+00 and 69+00.

26. Flow conditions. A study of flow conditions through the improved reach was made for both flows with the aid of floating confetti

and infusions of dye (fig. 3, page 14). For the lower discharge the model indicated flow conditions to be generally satisfactory. In the case of the design flow, however, the model indicated two, and possibly three, conditions of potential danger. The first of these, already mentioned in the preceding paragraph, was the proximity of the water surface to Highway 87 bridge structure; the second was the indication of the impingement of high-velocity flow against the north abutment of the Highway 190 bridge (fig. 3a); and the possible third was a less violent impingement of high-velocity flow against the nose of the north (left) bank opposite the lower end of the sharp bend in the improved channel above the railroad bridge (fig. 3c). Another questionable condition of flow existed in the south-bank approach to the railroad bridge, but since this was the subject of an additional series of tests it is discussed later in this report.

27. Transverse water-surface elevations. As can be seen on plate 1 the right bank levee upstream from the Gulf, Colorado and Santa Fe Railroad bridge closely parallels a concave bend in the proposed channel. In order to determine whether superelevated flow will exist along this section of levee, transverse water-surface elevations for both flows were observed at channel center line stations 19+25, 24+57, and 33+55. Results of these observations (tables 3 and 4) indicated that a pronounced superelevation in water surface would exist along the levee section. For the 206,000 cfs flow, the superelevation amounted to 3.6 ft, 2.4 ft, and 1.2 ft at center line stations 19+25, 24+57, and 33+55, respectively, with slightly lower amounts noted for the 86,000 cfs flow.

28. Velocity observations. Velocity measurements for both flows were taken with a pitot tube across selected ranges throughout the

a. Discharge, 206,000 cfs

b. Discharge, 86,000 cfs

c. Discharge, 206,000 cfs

d. Discharge, 86,000 cfs

Fig. 3. Flow through sections of the improved reach for two discharges selected for test -- test 1, original design (confetti streaks show surface current directions and relative velocities, dye used to delineate subsurface currents)

improvement and about all bridge abutments (see tables 5-10 and plates 4-23). Results of these tests indicated maximum velocities of approximately 16 to 20 ft per sec for a flow of 86,000 cfs, and approximately 22 to 31 ft per sec for a flow of 206,000 cfs. The highest velocities were obtained at the railroad bridge. Spot-velocity observations about the bridge abutments for the higher flow revealed maximum velocities as follows: 11.3 to 18.7 ft per sec at the north abutment of Highway 87 bridge and 16.4 to 21.5 ft per sec at the south abutment; 18.2 to 20.4 ft per sec at the north abutment of the Highway 190 bridge and 8.0 to 14.3 ft per sec at the south abutment; 20.4 to 24.1 ft per sec at the north abutment of the railroad bridge and 16.4 to 25.4 ft per sec at the south abutment. Velocities at the same points for the flow of 86,000 cfs were much lower, none being observed in excess of 10.3 ft per sec.

Test 2 -- Levee and Abutment Modifications

Description

29. In the study of flow conditions at the Gulf, Colorado and Santa Fe Railroad bridge for a flow of 206,000 cfs, it was observed that overbank flow impinging against the railroad causeway south of the bridge was deflected too far into the channel, causing unequal distribution of flow between the first two spans of the bridge. In an effort to alleviate this condition the south abutment of the bridge was extended 10 ft upstream and tied into the levee on the south bank by three different plans involving warped channel side slopes extending to levee stations 10+00, 5+00, and 2+50. The elements of the three modifications

(designated modifications 1, 2, and 3, respectively) tested are shown on plates 24, 25 and 26.

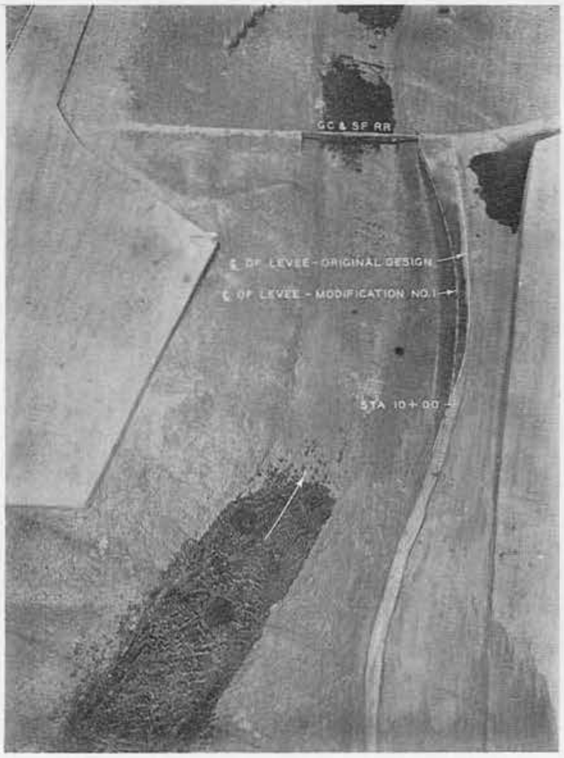
Results

30. Fig. 4a, 5a, and 6a show the three levee and abutment modifications as installed in the model. Fig. 4b and c, 5b and c, and 6b and c, show flow conditions existing at the Gulf, Colorado and Santa Fe Railroad bridge for the two test flows with the three modifications, respectively. The resulting water-surface elevations for the tests of each modification for discharges of 206,000 and 86,000 cfs are shown in tables 11 and 12, respectively. Examination of these data reveals that, of the three plans tested the one consisting of the 10-ft abutment extension and the warped channel side slope to station 5+00 (modification 2) appeared to be the most satisfactory. It produced a more equal distribution of flow and lowered the water surface immediately above the bridge by 0.9 ft.

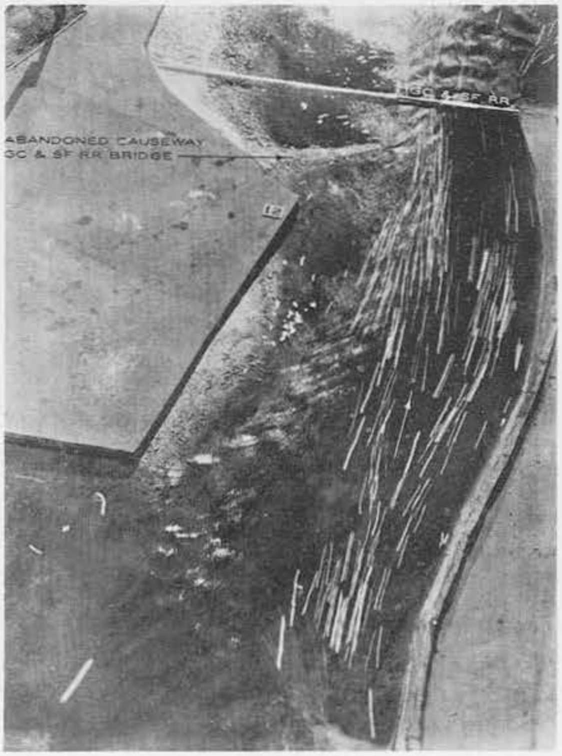
Test 3 -- Floodwall Modification

Description

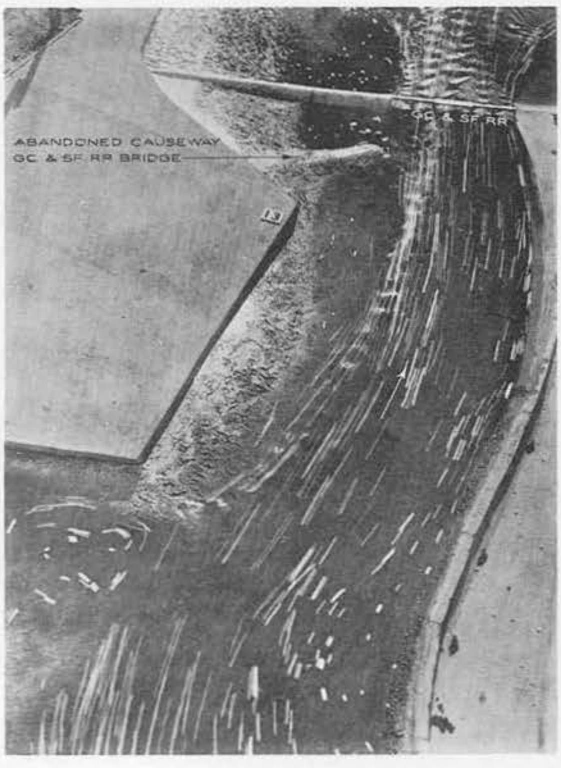
31. The improvement plan as originally designed contemplated moving the existing municipal water and light plant out of the flooded area, thus providing sufficient area for construction of the right-bank levee. Further study of the project plan indicated the feasibility of allowing the water and light plant to remain in its existing location and protecting it from flood waters by construction of a concrete floodwall between levee stations 56+80 and 69+40.15. Test 3 was made to determine the hydraulic effects resulting from replacing the originally



a. Dry bed

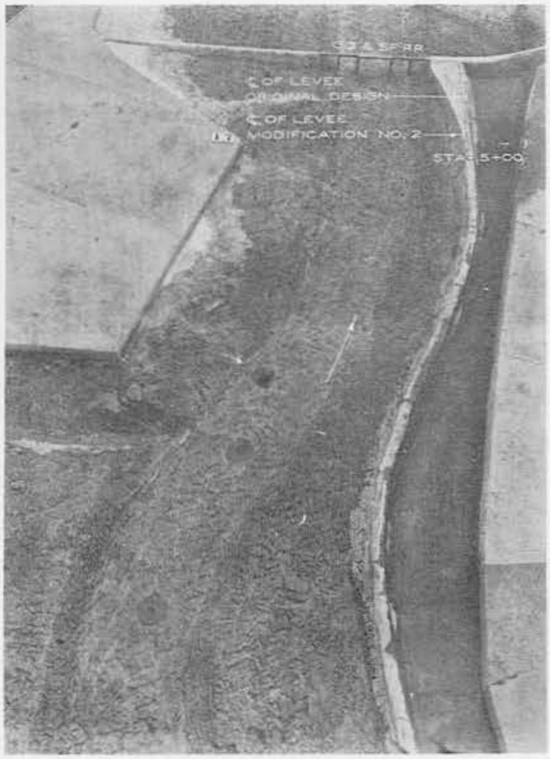


b. Discharge, 206,000 cfs

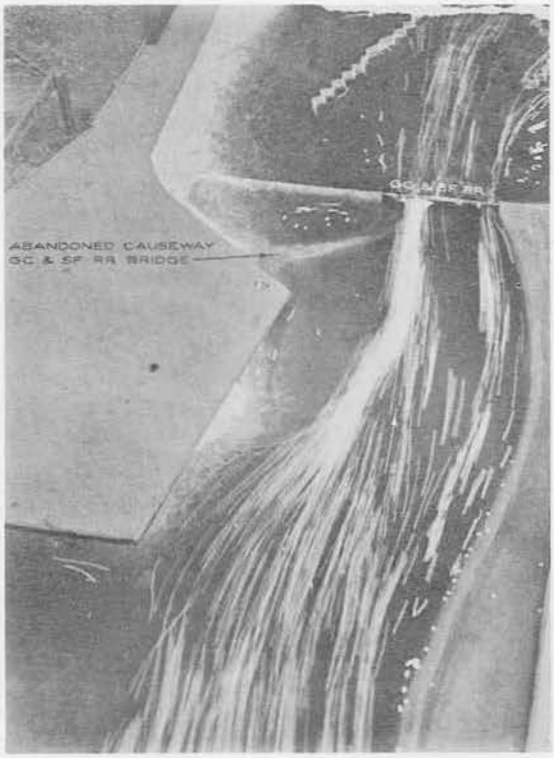


c. Discharge, 86,000 cfs

Fig. 4. Test 2
Levee and abutment modification no. 1 (10-ft abutment extension and warped channel side slopes extended to station 10+00), and effects on two selected discharges



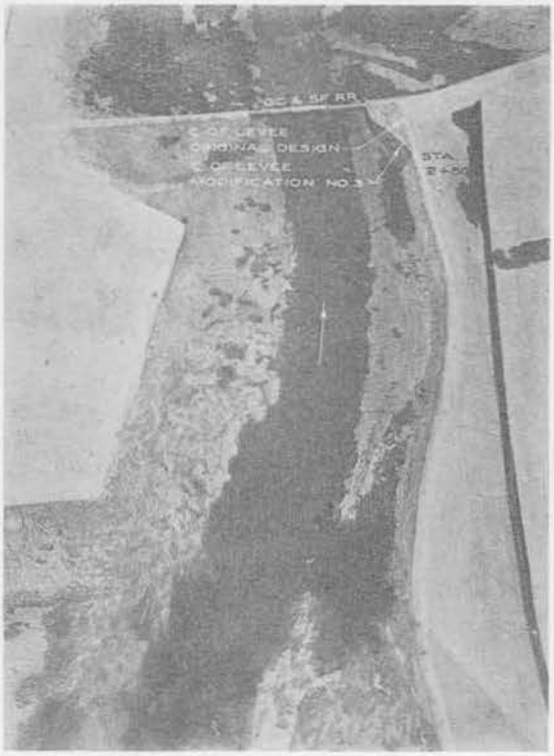
a. Dry bed



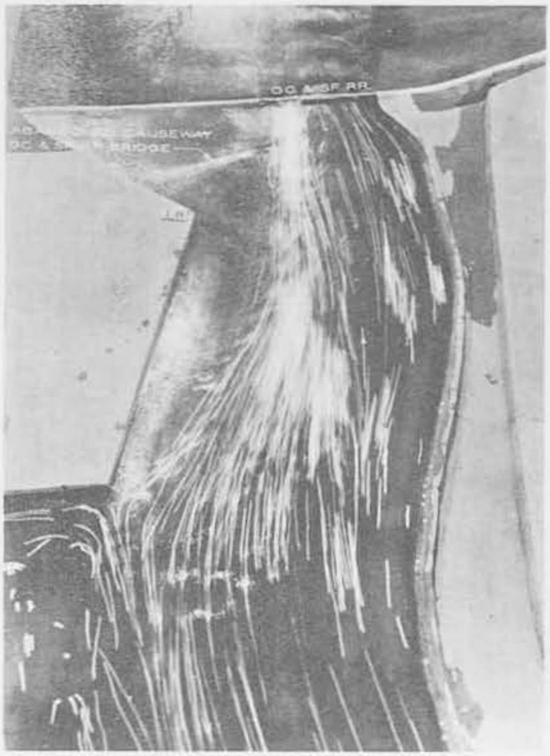
b. Discharge, 206,000 cfs

c. Discharge, 86,000 cfs

Fig. 5. Test 2
Levee and abutment modification no. 2 (10-ft abutment extension and warped channel side slopes extended to station 5+00), and effects on two selected discharges.

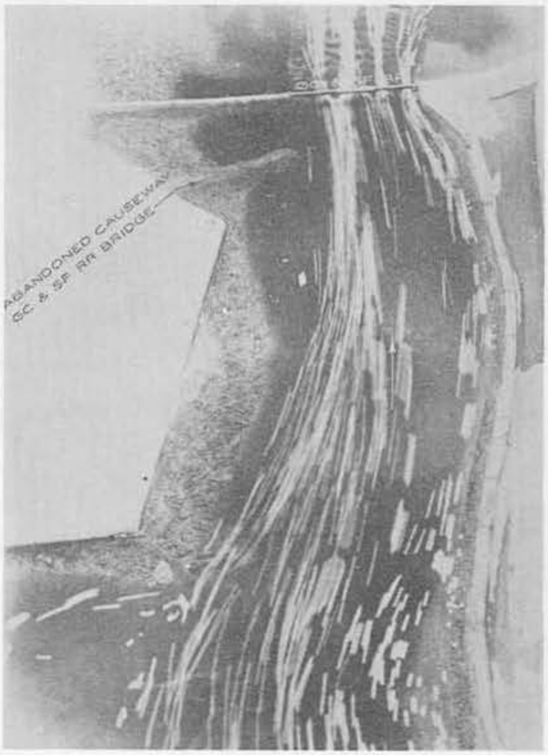


a. Dry bed



b. Discharge, 206,000 cfs

Fig. 6. Test 2
Levee and abutment modification no. 3 (10-ft abutment extension and warped channel side slopes extended to station 2+50), and effects on two selected discharges



c. Discharge, 86,000 cfs

proposed levee between stations 56+80 and 69+40.15 with this floodwall.

Results

32. Tests made on the above-described revision to the project plans indicated no appreciable hydraulic effect. Therefore, no supporting data on this test are presented in this report.

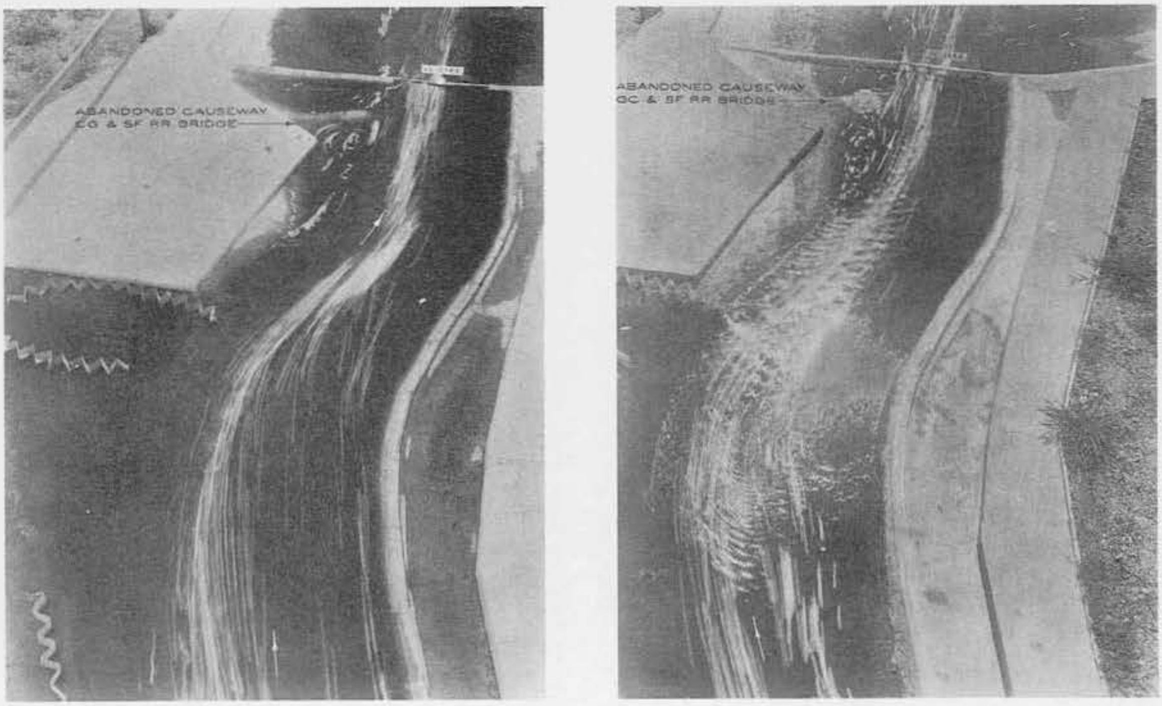
Test 4 -- Abandoned Causeway Modification

Description

33. In the discussion of results of the test of the original design, mention was made of the existence of apparently undesirable flow conditions in the south-bank approach to the Gulf, Colorado and Santa Fe Railroad bridge. It was thought that these conditions could be somewhat alleviated by reducing the length of the abandoned railroad causeway. Accordingly this phase of the investigation was concerned with reducing the length of the causeway. The modifications tested consisted of reducing the length of the abandoned causeway 25 ft in modification 1 and 50 ft in modification 2.

Results

34. Flow conditions resulting from reducing the length of the abandoned causeway 25 ft and 50 ft can be seen on fig. 7 and 8. Model water-surface elevations obtained for flows of 86,000 cfs and 206,000 cfs for each modification are presented in table 13. Examination of the results of this test indicates that no beneficial effect on flow conditions is to be expected from either of the modifications.



a. Discharge, 206,000 cfs

b. Discharge, 86,000 cfs

Fig. 7. Test 4, modification no. 1 (abandoned causeway shortened 25 ft)

a. Discharge, 206,000 cfs

b. Discharge, 86,000 cfs

Fig. 8. Test 4, modification no. 2 (abandoned causeway shortened 50 ft)

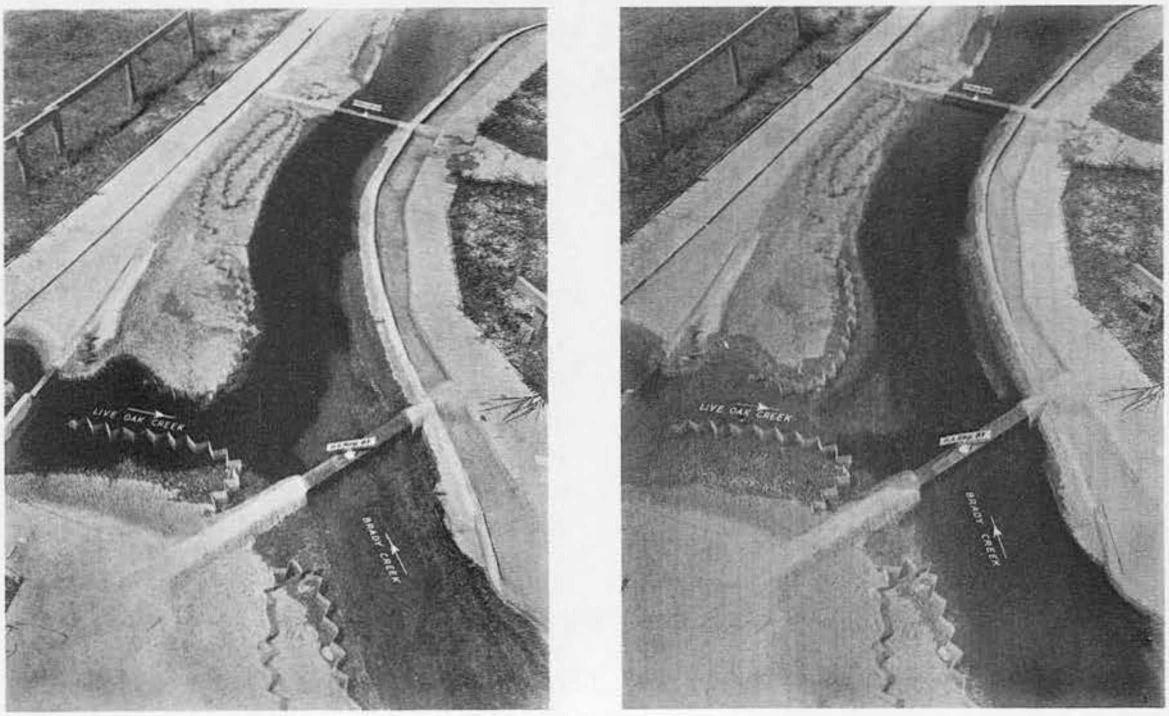
Test 5 -- Live Oak Creek Flood

Description

35. The test floods used in all previous tests were developed on the assumption that all flow entering the problem area would be supplied by Brady Creek and that no flow would be supplied by Live Oak Creek. However, since there is a distinct possibility of a flood resulting from the coincidence of a flood crest on Live Oak Creek during the progress of a flood on Brady Creek, it was deemed desirable to investigate this situation in the model. Accordingly, test 5 was made with Brady Creek supplying 50,000 cfs and Live Oak Creek supplying 25,000 cfs, for a total flood peak of 75,000 cfs.

Results

36. Model water-surface elevations observed in test 5 are presented in table 14; velocity observations at selected ranges in Brady Creek below its junction with Live Oak Creek are presented on plates 27 and 28; and flow conditions at the junction of the two creeks are shown on fig. 9. Location of velocity-observation ranges are shown on plate 1. It will be noted from a comparison of the velocity observations for the 86,000 cfs flow in test 1 and the velocities observed for the 75,000 cfs flow in test 5, the velocities observed in the latter test were about 10 per cent higher than those observed in test 1, although the flow was 11,000 cfs less. No undesirable flow conditions can be detected from the photographs of the flow conditions at the junction of Brady and Live Oak Creeks. The cloudy area on fig. 9a depicts the Live Oak Creek flow, and, similarly, fig. 9b depicts the Brady Creek flow. It will be noted that



a. Cloudy area denotes Live Oak Creek flow

b. Cloudy area denotes Brady Creek flow

Fig. 9. Test 5, Live Oak Creek flood. Flow at junction of Live Oak Creek and Brady Creek.
Live Oak Creek discharge, 25,000 cfs; Brady Creek discharge, 50,000 cfs

the turbulence caused by the abrupt convergence of Brady and Live Oak Creek flows effected a slight overlapping of the cloudy areas of fig. 9.

PART IV: RECOMMENDATIONS

37. Based upon results of the tests conducted in the model study for flood protection at Brady, Texas, the following recommendations with regard to the construction of the prototype project are advanced for consideration:

a. To insure the desired 1-ft freeboard for the design flow of 206,000 cfs, the project grade of the levee should be raised 1.0 to 1.5 ft between levee stations 35+00 and 69+00.

b. To insure the safety of Highway 87 bridge, the low steel elevation of the structure should be raised at least 0.8 ft to give a clearance of 1 ft.

c. The designs of the bridge structures and protective riprap should be examined critically in the light of the magnitude of observed velocities to insure their ability to withstand the forces of erosion and impact.

d. Consideration should be given to a modification of the south bank approach to the Gulf, Colorado and Santa Fe Railroad bridge similar to the one developed in the model (modification 2, test 2).

TABLES

Table 1

COMPARISON OF MODEL AND COMPUTED
WATER-SURFACE ELEVATIONS ALONG CENTER LINE OF CHANNEL

TEST 1 -- DISCHARGE, 206,000 CFS

	Water-surface elevations in feet msl		
		Computed*	
Gage No.	Model	"A"	"B"
1	1693.3	1691.3	1691.3
2	1692.3	1689.3	1689.3
3	1690.5	1691.0	1688.5
4	1688.5	1690.4	1688.0
5.	1688.0	1689.2	1686.3
6	1687.8	1688.0	1686.1
7	1686.9	1686.0	1685.2
8	1684.7	1685.0	1684.2
9	1683.3	1683.0	1682.0
10	1683.3	1683.0	1681.2
11	1682.3	1682.3	1680.0
12	1681.7	1681.3	1679.5
13	1679.5	1680.0	1678.5
14	1676.5	1677.5	1677.7
15	1673.7	1675.5	1676.7
16	1674.5	1675.0	1675.0
17	1673.8	1674.2	1674.2
18	1673.2		1673.5

See plate 1 for gage locations

* Computed by Galveston District, CE
"A" Velocity head change considered
"B" Velocity head change neglected

Table 2

WATER-SURFACE ELEVATIONS ALONG LEVEE

TEST 1 -- DISCHARGE, 206,000 CFS

Levee Station	Elevation in Feet msl: Water Surface	Elevation in Feet msl: Levee Grade	+ = Overtop, - = Freeboard (prototype feet)
69+00	1692.3	1694.0	-1.7
65+00	1691.0	1690.8	+0.2
60+00	1689.1	1689.3	-2.0
55+00	1687.4	1688.7	-1.3
50+00	1687.6	1688.2	-0.6
45+00	1687.4	1687.6	-0.2
40+00	1686.8	1687.1	-0.3
35+00	1683.1	1686.7	-3.6
30+00	1683.9	1686.0	-2.1
25+00	1683.7	1685.5	-1.8
20+00	1681.8	1685.0	-3.2
15+00	1681.6	1684.5	-2.9
10+00	1680.5	1684.0	-3.5
5+00	1680.5	1683.4	-2.9
0+00	1679.6	1682.8	-3.2

See plate 1 for levee station location

Table 3

TRANSVERSE WATER-SURFACE ELEVATIONS

TEST 1 -- DISCHARGE, 206,000 CFS

Location			Elevation in ft (Prototype)
Station along center line of channel	Distance in ft normal to channel center line: Left (North)	Distance in ft normal to channel center line: Right (South)	
19+25	0	0	1676.5
"	90		1676.3
"	180		1676.5
"	270		1676.3
"	360		1675.9
"	450		1676.0
"	540		1676.4
"	630		1676.6
"		90	1677.4
"	-	180	1678.7
"		255	1679.5
24+57	0	0	1679.7
"	90		1679.3
"	180		1678.5
"	270		1679.4
"	360		1679.0
"		90	1680.0
"	-	180	1680.5
"		270	1680.9
33+55	0	0	1680.0
"	90		1679.8
"	180		1679.5
"	270		1679.7
"		90	1680.5
"		180	1680.8
"		265	1680.7

Table 4

TRANSVERSE WATER-SURFACE ELEVATIONS

TEST 1 -- DISCHARGE, 86,000 CFS

Location			Elevation in ft (Prototype)
Station along center line of channel	Distance in ft normal to channel center line		
	Left	Right	
19+25	0	0	1667.2
"	0		1667.1
"	180		1666.9
"	270		1666.7
"	360		1666.9
"	435		1667.3
"		90	1667.4
"	-	180	1667.8
"		240	1667.9
24+57	0	0	1668.4
"	0		1668.4
"	180		1667.9
"	270		1667.9
"	345		1668.0
"		90	1668.6
"	-	180	1668.7
"		248	1668.3
33+55	0	0	1668.5
"	90		1668.6
"	180		1667.8
"	228		1667.7
"		90	1668.6
"		180	1668.8
"		225	1668.8

Table 5

VELOCITY OBSERVATIONS AT U.S. HIGHWAY 87 BRIDGE
TEST 1 -- DISCHARGE, 206,000 CFS

Location					
Distance in ft from channel center line along bridge center line		Distance in ft from bridge center line along line parallel to channel center line		Elevation in ft (prototype)	Velocity ft/sec (prototype)
Left (West)	Right (East)	Upstream	Downstream		
231	-	-	60	1678.5	1.6
190	-	-	72	1658.5	4.0
190	-	-	72	1668.5	1.6
190	-	-	72	1678.5	1.6
175	-	-	34	1656.5	9.6
175	-	-	34	1666.5	11.3
175	-	-	34	1676.5	8.7
165	-	-	28	1655.5	11.8
165	-	-	28	1665.5	13.9
165	-	-	28	1675.5	9.6
165	-	-	28	1680.5	9.6
104	-	-	28	1650.5	11.8
104	-	-	28	1660.5	17.9
104	-	-	28	1670.5	16.9
104	-	-	28	1680.5	14.9
25	-	-	28	1651.5	18.2
25	-	-	28	1661.5	22.7
25	-	-	28	1671.5	22.0
25	-	-	28	1681.5	18.7
-	54	-	28	1658.5	24.1
-	54	-	28	1668.5	24.7
-	54	-	28	1678.5	23.4
-	114	-	28	1658.5	21.5
-	114	-	28	1658.5	24.7
-	114	-	28	1678.5	23.4
-	189	-	28	1657.5	14.9
-	189	-	28	1667.5	18.7
-	189	-	28	1677.5	19.9
-	214	-	27	1669.5	18.7
-	214	-	27	1679.5	19.6
-	226	-	34	1671.0	19.6
-	226	-	34	1676.0	21.5
-	240	-	51	1672.5	20.7
-	240	-	51	1682.5	20.4
-	270	-	45	1682.5	4.0
231	-	58	-	1680.5	18.7
190	-	70	-	1670.5	16.0
190	-	70	-	1680.5	18.7
181	-	40	-	1671.5	16.0
181	-	40	-	1681.5	18.7
181	-	39	-	1665.0	13.1
181	-	39	-	1675.0	8.0
165	-	39	-	1667.5	16.4
165	-	39	-	1677.5	16.9
104	-	39	-	1662.5	18.2
104	-	39	-	1672.5	17.3
25	-	39	-	1661.5	22.7
25	-	39	-	1671.5	21.5
25	-	39	-	1681.5	19.9
-	54	39	-	1660.5	24.1
-	54	39	-	1670.5	24.1
-	54	39	-	1680.5	22.7
-	114	39	-	1662.0	22.3
-	114	39	-	1672.0	23.7
-	114	39	-	1682.0	23.4
-	189	39	-	1665.5	16.4
-	189	39	-	1675.5	19.1
-	189	39	-	1680.5	22.7
-	214	39	-	1674.5	14.9
-	214	39	-	1684.5	16.4
-	234	39	-	1677.0	16.4
-	234	39	-	1682.0	15.4
-	234	63	-	1672.5	11.3
-	234	63	-	1682.5	13.1
-	270	51	-	1682.5	1.6

Table 6

VELOCITY OBSERVATIONS AT U.S. HIGHWAYS 190 & 283 BRIDGE
TEST 1 -- DISCHARGE, 206,000 CFS

Location: Distance in ft from channel center line along bridge center line		Location: Distance in ft from bridge center line along line parallel to channel center line		Elevation in ft (prototype)	Velocity ft/sec (prototype)
Left (North)	Right (South)	Upstream	Downstream		
202.5	-	-	42.0	1677.5	5.6
178.5	-	-	49.5	1699.5	9.6
178.5	-	-	49.5	1677.5	13.9
166.5	-	-	28.5	1663.5	18.2
166.5	-	-	28.5	1673.5	17.9
138.0	-	-	28.5	1655.0	19.9
138.0	-	-	28.5	1665.0	23.4
138.0	-	-	28.5	1675.0	24.4
60.0	-	-	28.5	1644.0	19.9
60.0	-	-	28.5	1654.0	28.9
60.0	-	-	28.5	1664.0	28.9
60.0	-	-	28.5	1674.0	28.9
-	52.5	-	28.5	1644.0	19.9
-	52.5	-	28.5	1654.0	25.4
-	52.5	-	28.5	1664.0	25.6
-	52.5	-	28.5	1674.0	25.0
-	72.0	-	28.5	1645.5	20.7
-	72.0	-	28.5	1655.5	24.4
-	72.0	-	28.5	1665.5	23.4
-	72.0	-	28.5	1675.5	23.4
-	132.8	-	28.5	1659.0	16.4
-	132.8	-	28.5	1669.0	20.4
-	132.8	-	28.5	1674.0	21.2
-	166.5	-	28.5	1669.5	8.0
-	166.5	-	28.5	1679.0	5.6
-	174.0	-	45.0	1670.5	4.0
-	174.0	-	45.0	1677.0	4.0
-	197.3	-	42.0	1672.0	0.0
199.5	-	45.0	-	1680.5	4.0
175.5	-	56.3	-	1666.5	13.9
175.5	-	56.3	-	1676.5	17.9
165.0	-	36.0	-	1662.0	19.6
165.0	-	36.0	-	1672.0	20.4
138.0	-	36.0	-	1654.0	17.9
138.0	-	36.0	-	1664.0	21.2
138.0	-	36.0	-	1674.0	22.3
138.0	-	36.0	-	1679.0	22.7
47.3	-	36.0	-	1645.5	23.7
47.3	-	36.0	-	1655.5	26.6
47.3	-	36.0	-	1665.5	26.6
47.3	-	36.0	-	1675.5	26.0
-	20.2	36.0	-	1645.5	23.0
-	20.2	36.0	-	1655.5	24.4
-	20.2	36.0	-	1665.5	23.0
-	20.2	36.0	-	1675.5	21.2
-	75.0	36.0	-	1645.5	18.7
-	75.0	36.0	-	1655.5	24.4
-	75.0	36.0	-	1665.5	23.0
-	75.0	36.0	-	1675.5	21.2
-	135.0	36.0	-	1662.0	18.2
-	135.0	36.0	-	1672.0	19.1
-	135.0	36.0	-	1675.0	20.4
-	165.0	36.0	-	1673.0	14.3
-	175.5	46.5	-	1676.5	14.9
-	199.5	46.5	-	1678.5	4.0

Table 7

VELOCITY OBSERVATIONS AT G.C. & S.F. R.R. BRIDGE
TEST 1 -- DISCHARGE, 206,000 CFS

Station along center line of channel	Location: Distance in ft normal to center line, Left (North)	Location: Distance in ft normal to center line, Right (South)	Elevation in ft (prototype)	Velocity ft/sec (prototype)
18+05	202.8	-	1658.1	4.0
18+05	202.8	-	1670.6	4.0
18+00	172.8	-	1660.1	12.6
18+00	172.8	-	1670.1	13.9
18+20	150.3	-	1654.1	22.3
18+20	150.3	-	1664.1	23.7
18+20	150.3	-	1669.1	24.1
18+42.5	142.8	-	1654.1	23.0
18+42.5	142.8	-	1664.1	28.0
18+42.5	142.8	-	1669.1	24.7
18+44	82.8	-	1641.1	27.8
18+44	82.8	-	1651.1	30.5
18+44	82.8	-	1661.1	29.7
18+44	82.8	-	1671.1	30.2
18+35	0	-	1640.6	23.7
18+35	0	-	1650.6	28.6
18+35	0	-	1660.6	29.1
18+35	0	-	1670.6	28.0
18+44	-	82.8	1641.6	27.4
18+44	-	82.8	1652.1	28.0
18+44	-	82.8	1668.1	28.0
18+42.5	-	142.8	1661.1	26.8
18+42.5	-	142.8	1667.1	29.7
18+20	-	150.3	1659.6	16.4
18+20	-	150.3	1670.1	11.3
17+85.5	-	172.8	1661.6	4.0
17+85.5	-	172.8	1669.1	5.6
18+05	-	202.8	1668.3	1.6
19+10	202.8	-	1661.1	4.0
19+10	202.8	-	1672.1	1.6
19+10	172.8	-	1656.6	8.7
19+10	172.8	-	1672.1	5.6
18+95	150.3	-	1654.6	18.7
18+95	150.3	-	1671.1	20.4
18+65	142.8	-	1654.1	21.2
18+65	142.8	-	1664.1	23.7
18+65	142.8	-	1669.1	23.0
18+68	82.8	-	1641.1	25.6
18+68	82.8	-	1651.1	28.3
18+68	82.8	-	1661.1	27.4
18+68	82.8	-	1671.1	27.2
18+72.5	0	-	1641.1	23.7
18+72.5	0	-	1651.1	26.8
18+72.5	0	-	1661.1	26.8
18+72.5	0	-	1671.1	26.0
18+65	-	82.8	1641.1	25.4
18+65	-	82.8	1651.1	27.2
18+65	-	82.8	1661.1	26.0
18+65	-	82.8	1671.1	26.0
18+65	-	142.8	1660.1	26.6
18+65	-	142.8	1670.6	27.8
18+80	-	160.8	1662.6	25.0
18+80	-	160.8	1671.1	25.4
19+14.5	-	172.8	1662.1	19.6
19+14.5	-	172.8	1672.1	18.2
19+14.5	-	202.8	1662.6	8.0

Table 8

VELOCITY OBSERVATIONS AT U.S. HIGHWAY 87 BRIDGE
TEST 1 -- DISCHARGE, 86,000 CFS

Location: Distance in ft from channel center line along bridge center line		Location: Distance in ft from bridge center line along line parallel to channel center line		Elevation in ft (prototype)	Velocity ft/sec (prototype)
Left (West)	Right (East)	Upstream	Downstream		
27	-	-	28.5	1649.2	11.8
27	-	-	28.5	1659.2	16.0
27	-	-	28.5	1669.2	17.3
108	-	-	28.5	1649.2	8.0
108	-	-	28.5	1659.2	11.3
108	-	-	28.5	1669.2	12.6
168.8	-	-	28.5	1653.2	5.6
168.8	-	-	28.5	1663.2	8.0
168.8	-	-	28.5	1668.2	8.0
183	-	-	28.5	1657.7	4.0
183	-	-	28.5	1667.7	5.6
195	-	-	67.5	1659.2	0.0
195	-	-	67.5	1669.2	0.0
-	57	-	28.5	1646.7	10.3
-	57	-	28.5	1656.7	18.7
-	57	-	28.5	1666.7	19.6
-	57	-	28.5	1671.7	19.9
-	121.5	-	28.5	1646.7	4.0
-	121.5	-	28.5	1656.7	9.6
-	121.5	-	28.5	1666.7	13.1
-	121.5	-	28.5	1671.7	12.6
-	171	-	28.5	1656.2	4.0
-	171	-	28.5	1666.2	8.0
-	171	-	28.5	1671.2	8.0
-	220.5	-	28.5	1668.2	1.6
-	232.5	-	28.5	1669.2	1.6
-	235.5	-	52.5	1670.5	1.6
25.5	-	43.5	-	1649.2	9.6
25.5	-	43.5	-	1659.2	16.9
25.5	-	43.5	-	1669.2	17.9
25.5	-	43.5	-	1673.2	16.4
100.5	-	40.5	-	1649.2	9.6
100.5	-	40.5	-	1659.2	12.6
100.5	-	40.5	-	1669.2	13.1
100.5	-	40.5	-	1672.2	13.9
162	-	40.5	-	1657.2	8.0
162	-	40.5	-	1667.2	9.6
162	-	40.5	-	1672.2	10.3
183	-	40.5	-	1663.7	4.0
183	-	40.5	-	1671.7	5.6
195	-	87	-	1667.7	4.0
-	55.5	48	-	1649.2	13.9
-	55.5	48	-	1659.2	20.4
-	55.5	48	-	1669.2	20.4
-	55.5	48	-	1672.2	20.4
-	114	48	-	1649.7	4.0
-	114	48	-	1659.7	11.8
-	114	48	-	1669.7	12.6
-	165	51	-	1652.2	4.0
-	165	51	-	1662.2	8.0
-	165	51	-	1672.0	8.0
-	214.5	48	-	1663.2	0.0
-	214.5	48	-	1670.7	0.0
-	244.5	57	-	1670.7	0.0

Table 9

VELOCITY OBSERVATIONS AT U.S. HIGHWAYS 190 & 283 BRIDGE

TEST 1 -- DISCHARGE, 86,000 CFS

Location					
Distance in ft from channel center line along bridge center line		Distance in ft from bridge center line along line parallel to channel center line		Elevation in ft (Prototype)	Velocity in ft/sec (Prototype)
Left(North)	Right(South)	Upstream	Downstream		
59			26	1645.0	13.9
"			"	1655.0	17.9
"			"	1665.0	17.9
140			"	1657.5	13.1
"			"	1667.5	14.9
167			26	1665.5	9.6
167			45	1667.5	9.6
	20		26	1644.5	12.6
	"		"	1654.5	16.0
	"		"	1664.5	16.9
	75		"	1646.0	11.8
	"		"	1656.0	14.9
	"		"	1666.0	14.3
	135		"	1661.0	10.3
	"		"	1666.0	11.3
	153		26	1666.0	8.0
59		36		1645.5	14.9
"		"		1655.5	17.9
"		"		1665.5	17.3
140		"		1655.5	12.6
"		"		1665.5	14.9
168		36		1664.5	10.3
173		62		1665.0	9.6
177		72		1666.0	8.7
	20	36		1646.0	14.3
	"	"		1656.0	16.9
	"	"		1666.0	16.9
	75	"		1647.5	13.9
	"	"		1657.5	16.0
	"	"		1667.5	14.9
	135	36		1663.5	11.8

Table 10

VELOCITY OBSERVATIONS AT G.C. & S.F. R.R. BRIDGE
TEST 1 -- DISCHARGE, 86,000 CFS

Location				
Station along center line of channel	Distance in ft normal to channel center line		Elevation in ft (prototype)	Velocity ft/sec (prototype)
	Left	Right		
18+08	204.0	-	1658.1	4.0
18+04	172.5	-	1656.6	5.6
18+04	172.5	-	1661.6	8.0
18+33.5	167.2	-	1655.1	8.0
18+33.5	167.2	-	1663.1	8.7
18+45	165.0	-	1655.1	8.7
18+45	165.0	-	1663.1	8.7
18+45	141	-	1654.1	11.8
18+45	141	-	1664.1	13.9
18+42.5	81	-	1641.6	16.4
18+42.5	81	-	1651.6	19.6
18+42.5	81	-	1661.6	19.6
18+39.5	0	0	1641.1	13.9
18+39.5	0	-	1651.1	18.2
18+39.5	0	-	1661.1	18.2
18+44.75	-	82.5	1642.1	14.9
18+44.75	-	82.5	1652.1	18.2
18+44.75	-	82.5	1664.1	18.7
18+45.5	-	141	1660.1	12.6
18+21.5	-	162.7	1660.1	1.6
18+45.5	-	166.5	1661.6	1.6
17+82.5	-	172.5	1661.1	1.6
17+91.5	-	195.0	1663.1	1.6
19+05.5	204	-	1662.6	1.6
19+10	172.5	-	1657.6	1.6
19+10	172.5	-	1662.6	1.6
18+77	167.2	-	1656.1	8.0
18+77	167.2	-	1661.1	8.0
18+65	165.0	-	1655.6	8.0
18+65	165.0	-	1660.6	8.0
18+65	141.0	-	1654.1	11.8
18+65	141.0	-	1662.1	12.6
18+66.5	81.0	-	1641.6	14.9
18+66.5	81.0	-	1651.6	18.7
18+66.5	81.0	-	1661.6	18.7
18+70.25	0	0	1641.1	13.9
18+70.25			1651.1	16.9
18+70.25			1661.1	18.2
18+66.5	-	82.5	1642.1	14.3
18+66.5	-	82.5	1652.1	17.3
18+66.5	-	82.5	1662.1	17.9
18+65	-	141.0	1660.6	13.1
18+80	-	162.7	1662.6	5.6
18+65	-	166.5	1661.6	4.0
19+10	-	172.5	1662.6	9.6
19+01	-	195.0	1666.6	4.0

Table 11

LEVEE AND ABUTMENT MODIFICATIONS AT GC & SF RR BRIDGE
WATER-SURFACE ELEVATIONS

TEST 2 -- DISCHARGE, 206,000 CFS

Gage No.	Gage Location Center Line Station	Base Test	Levee and Abutment Modification No. 1	No. 2	No. 3
11	37+90	1682.3	1682.2	1682.2	1682.0
12	33+55	1681.7	1681.7	1681.6	1681.5
13	24+57	1679.5	1679.4	1679.3	1679.3
14	19+25	1676.5	1675.4	1675.5	1675.3
15	17+78	1673.7	1673.8	1673.6	1673.4
16	8+80	1674.5	1674.8	1674.5	1674.6
17	6+30	1673.8	1674.0	1673.8	1673.7
18	-2+90	1673.2	1673.3	1673.1	1673.0

See plates 24-26 for levee abutment modifications and plate 1 for gage locations.

Table 12

LEVEE AND ABUTMENT MODIFICATIONS AT GC & SF RR BRIDGE
WATER-SURFACE ELEVATIONS

TEST 2 -- DISCHARGE, 86,000 CFS

Gage No.	Gage Location Center Line	Base Test	Levee and Abutment Modification No. 1	No. 2	No. 3
11	37+90	1669.5	1669.6	1669.4	1669.4
12	33+55	1668.8	1669.0	1668.7	1668.7
13	24+57	1667.9	1668.0	1667.7	1667.8
14	19+25	1666.8	1667.0	1666.7	1666.7
15	17+78	1666.6	1666.9	1666.6	1666.6
16	8+80	1666.5	1666.8	1666.4	1666.5
17	6+30	1665.6	1665.8	1665.6	1665.6
18	-2+90	1664.8	1664.9	1664.6	1664.6

See plates 24-26 for levee abutment modifications and plate 1 for gage locations.

Table 13

MODIFICATION OF ABANDONED CAUSEWAY GC & SF RR BRIDGE
WATER-SURFACE ELEVATIONS

TEST 4

Gage No.	Gage Location** (Center Line Station)	Test 1*	Abandoned Causeway Shortened 25 ft	Abandoned Causeway Shortened 50 ft
		Q = 86,000 cfs		
11	37+90	1669.5	1669.5	1669.5
12	33+55	1668.8	1668.8	1668.8
13	24+57	1667.9	1667.9	1667.9
14	19+25	1666.8	1666.9	1667.1
15	17+78	1666.6	1666.6	1666.8
16	8+80	1666.5	1666.6	1666.7
		Q = 206,000 cfs		
11	37+90	1682.3	1682.1	1682.1
12	33+55	1681.7	1681.5	1681.6
13	24+57	1679.5	1679.5	1679.4
14	19+25	1676.5	1677.0	1676.8
15	17+78	1673.7	1673.6	1673.7
16	8+80	1674.5	1674.3	1674.6

*Abandoned causeway constructed as shown on plate 1.
** See plate 1 for gage locations.

Table 14

LIVE OAK CREEK FLOOD
WATER-SURFACE ELEVATIONS ALONG CENTER LINE OF CHANNEL

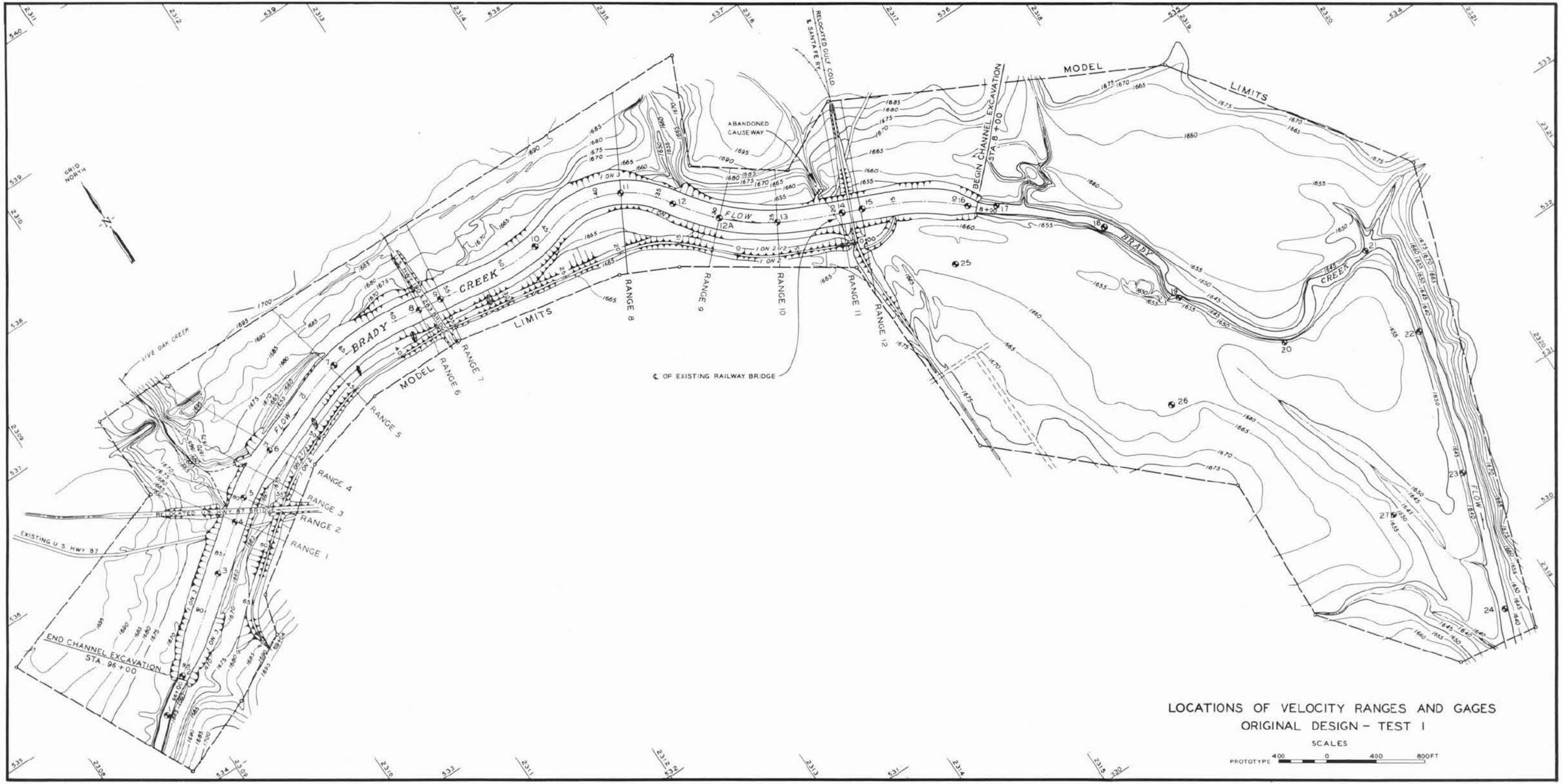
TEST 5 -- DISCHARGE, 75,000 CFS*

Gage No.	Gage Location** (Center Line Station)	Water Surface Elevation (in feet msl)
1	99+60	1674.8
2	95+77	1673.3
3	86+77	1673.6
4	82+22	1673.4
5	80+13	1673.5
6	75+50	1671.7
7	66+70	1670.9
8	57+90	1670.0
9	55+88	1669.7
10	46+95	1668.9
11	37+90	1667.9
12	33+55	1667.3
13	24+57	1666.7
14	19+25	1666.0
15	17+78	1665.9
16	8+80	1665.7

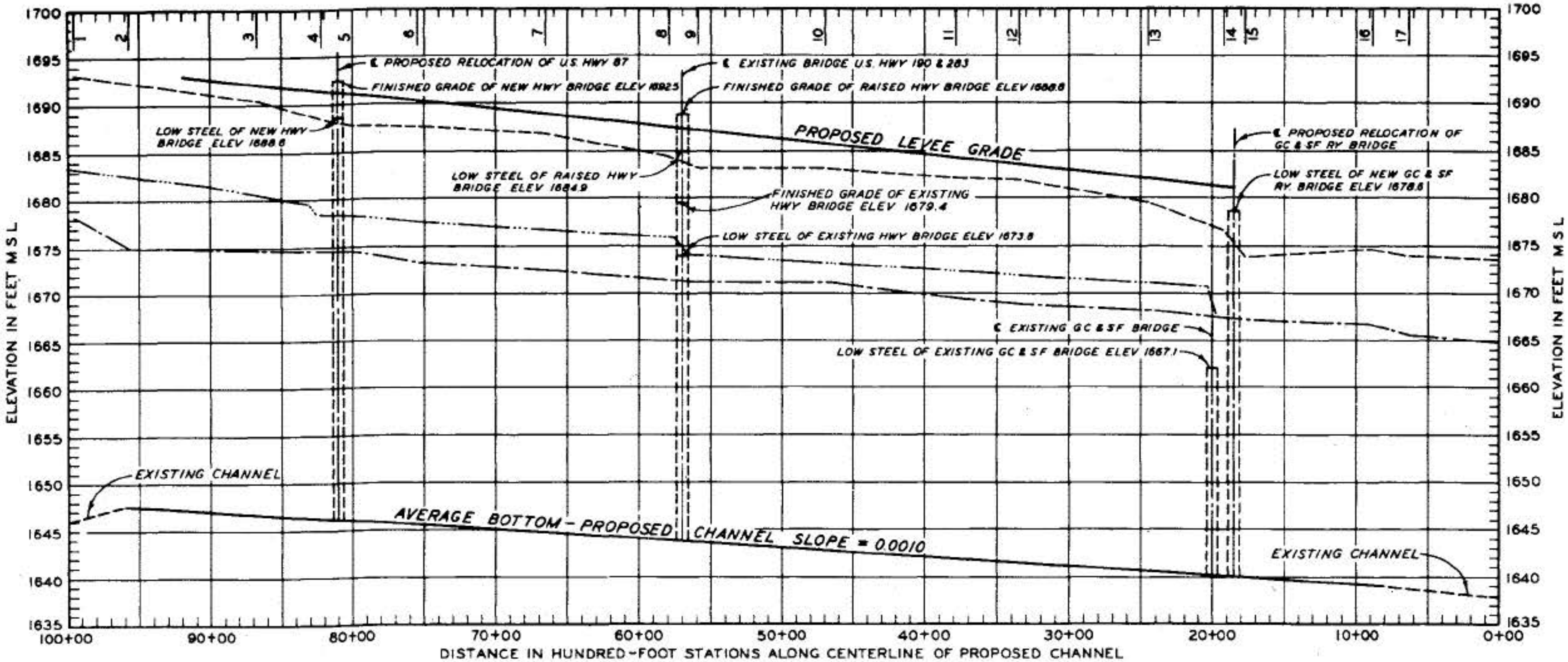
* Made up of 50,000 cfs in Brady Creek plus 25,000 cfs in Live Oak Creek.

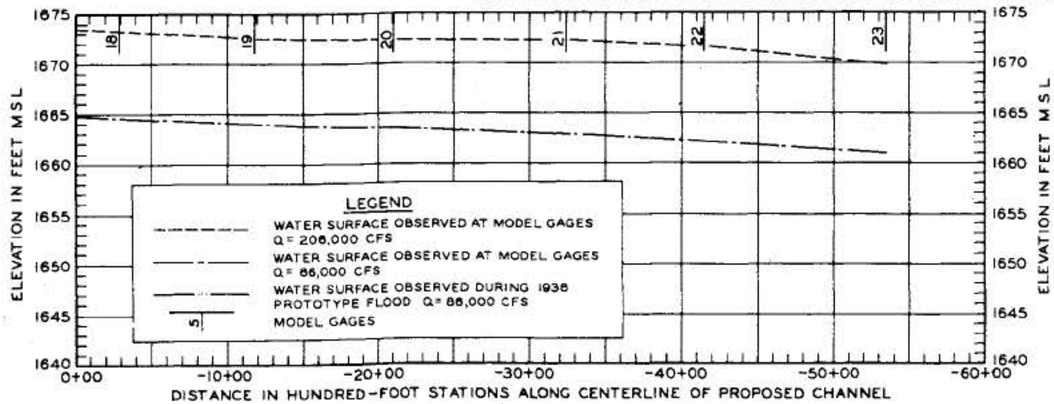
** See plate 1 for gage location.

PLATES



LOCATIONS OF VELOCITY RANGES AND GAGES
ORIGINAL DESIGN - TEST 1



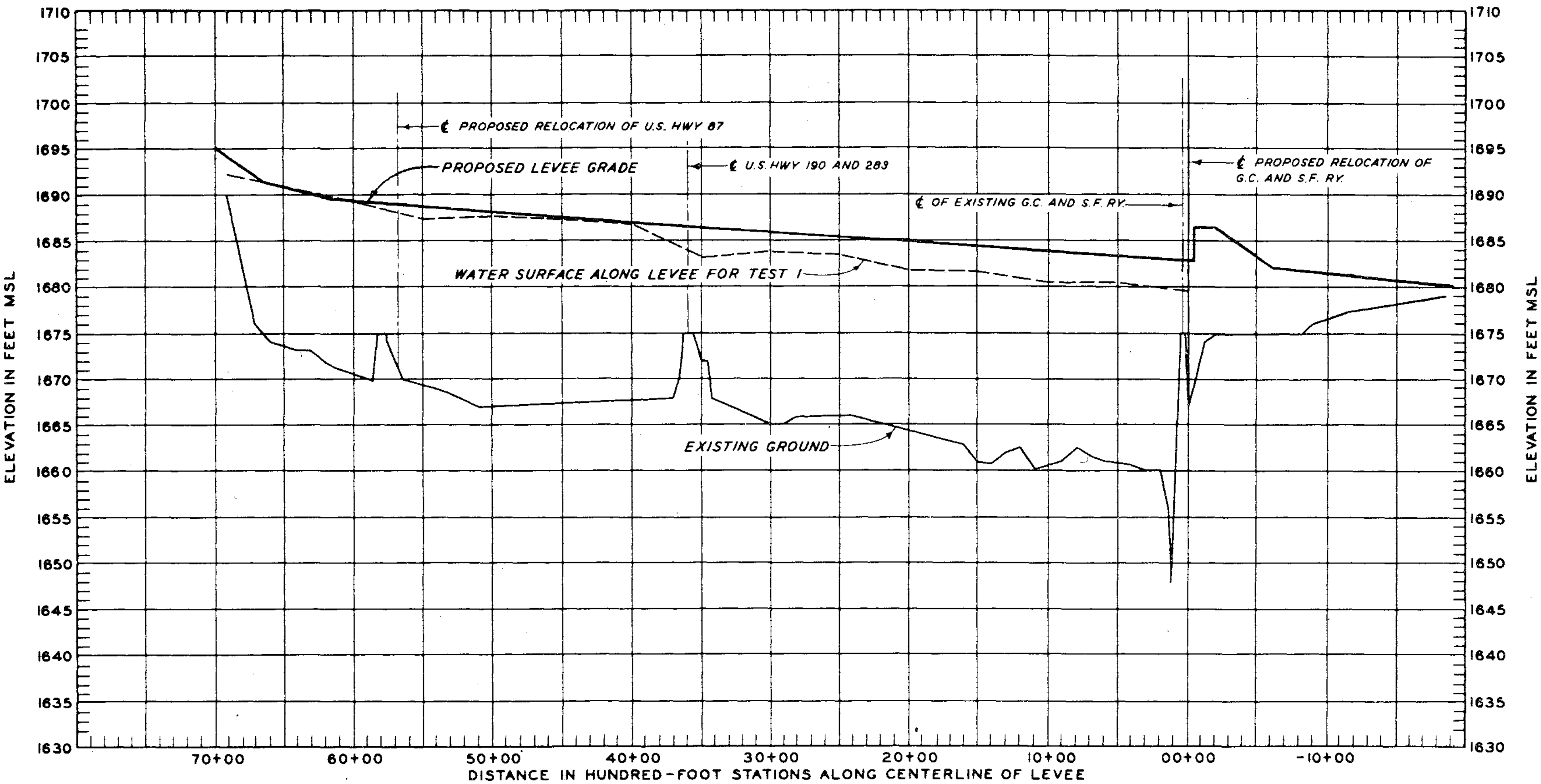


NOTE: FOR LOCATION OF MODEL GAGES AND CENTERLINE STATIONING OF CHANNEL SEE PLATE 1

PROFILES ALONG CENTER LINE OF CHANNEL

TEST 1 - ORIGINAL DESIGN

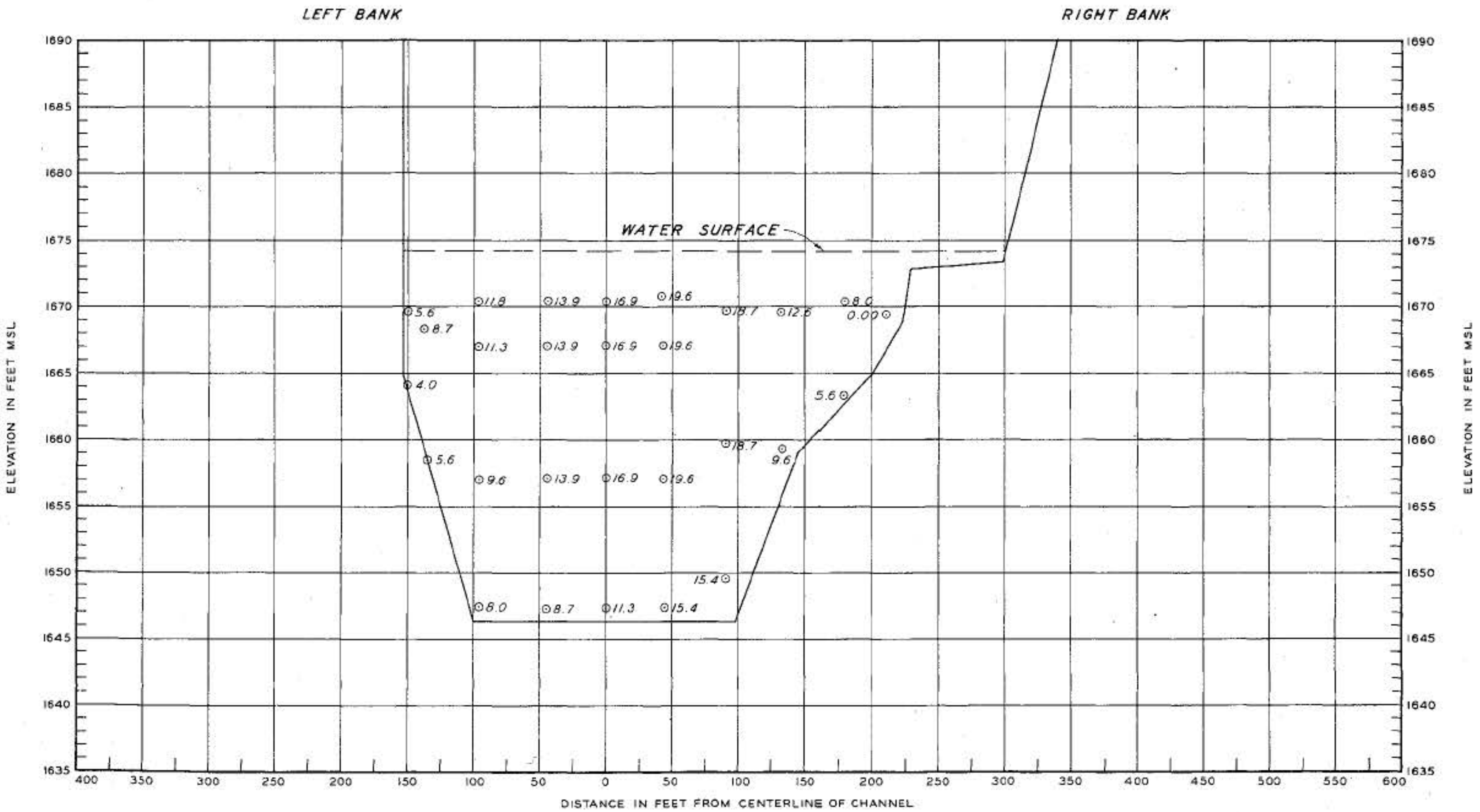
PLATE 3



NOTE: SEE PLATE I FOR LOCATION OF LEVEE STATIONS.

PROFILES ALONG LEVEE

TEST I - ORIGINAL DESIGN



LEGEND

⊙16.4 PROTOTYPE VELOCITIES IN FEET PER SECOND.

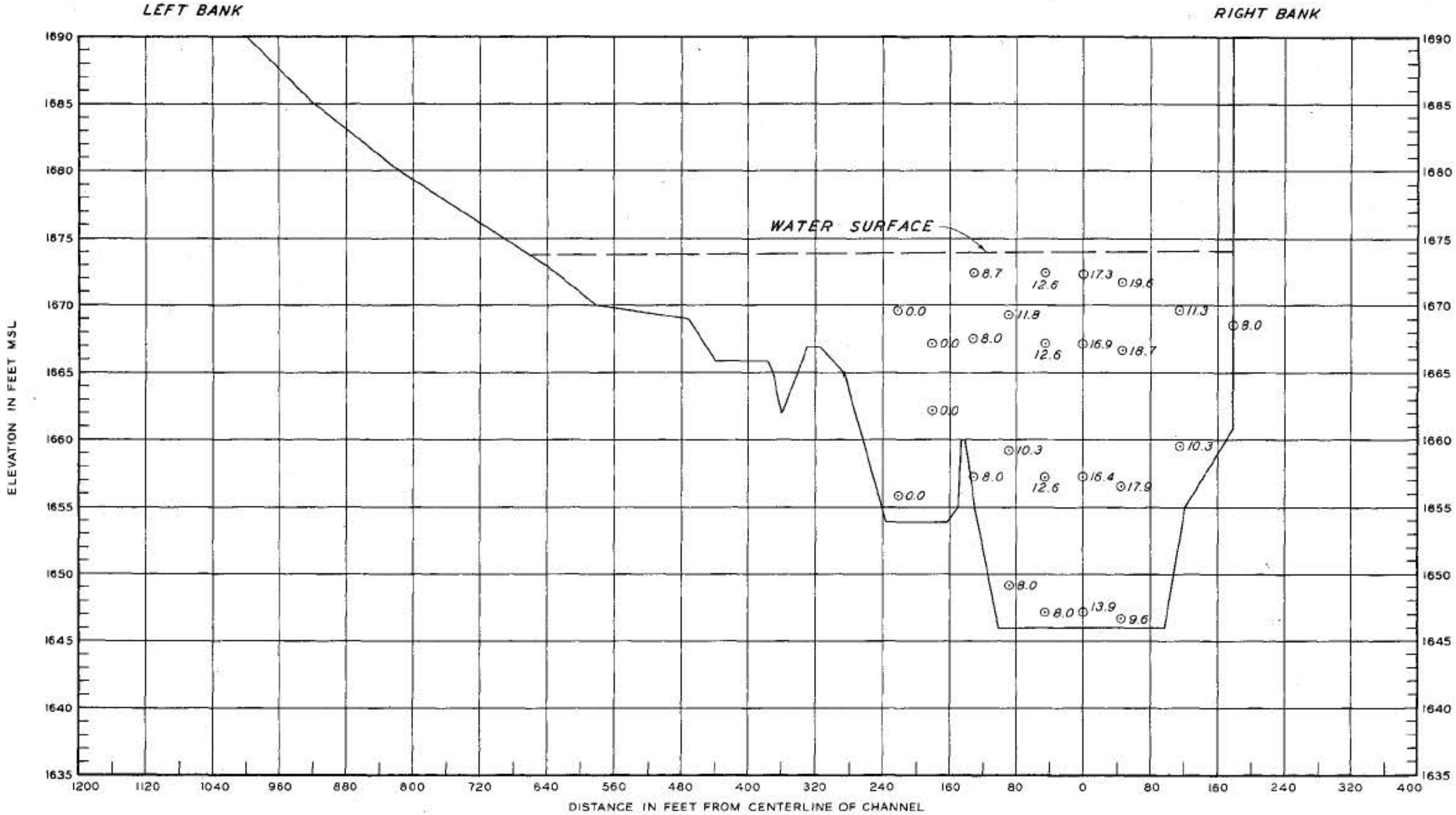
VELOCITY DISTRIBUTION

TEST I

STATION 82 + 22 – RANGE I

DISCHARGE: 86,000 CFS

PLATE 5



LEGEND

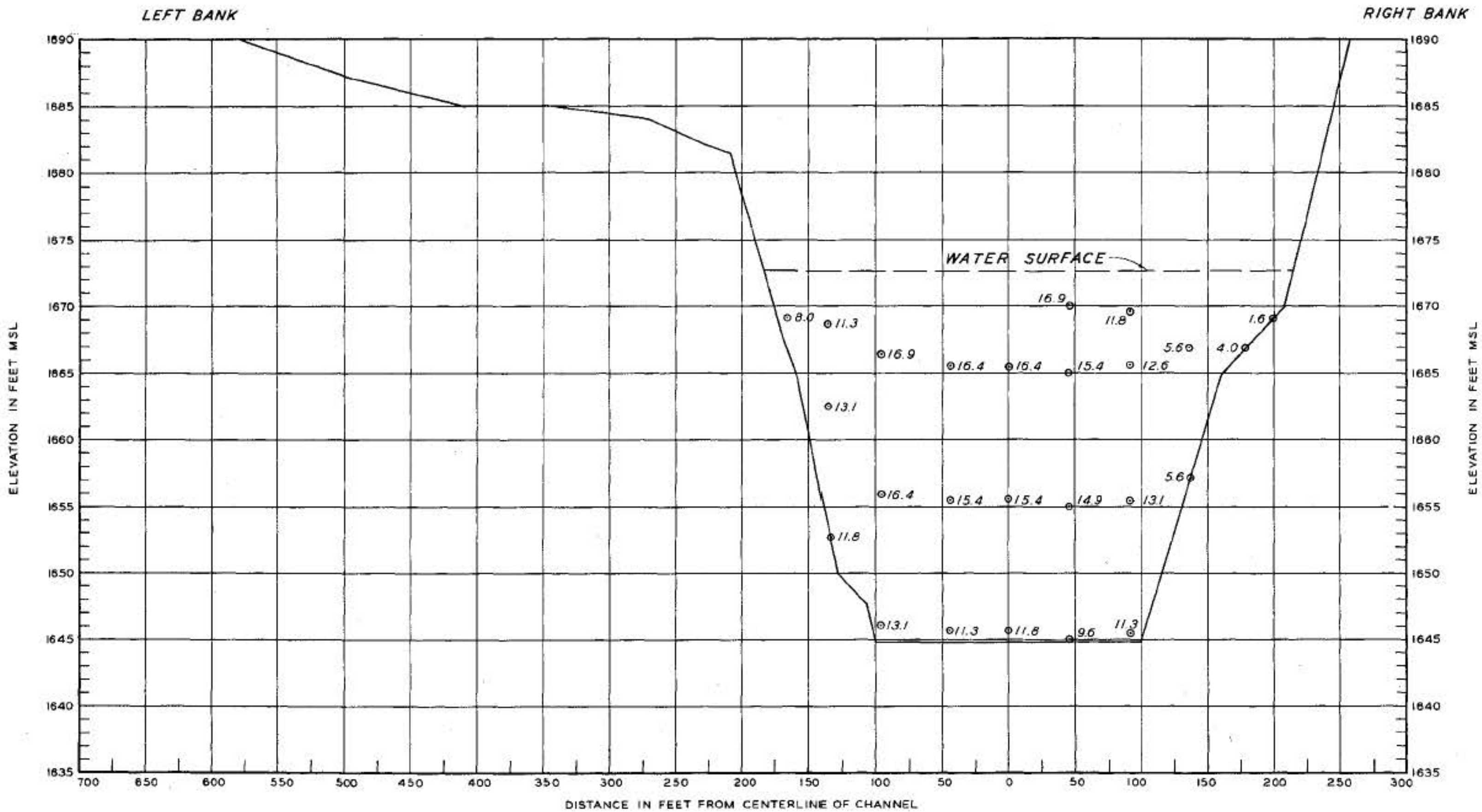
⊙16.4 PROTOTYPE VELOCITIES IN FEET PER SECOND.

VELOCITY DISTRIBUTION

TEST I

STATION 80+13 — RANGE 2

DISCHARGE: 86,000 CFS



LEGEND

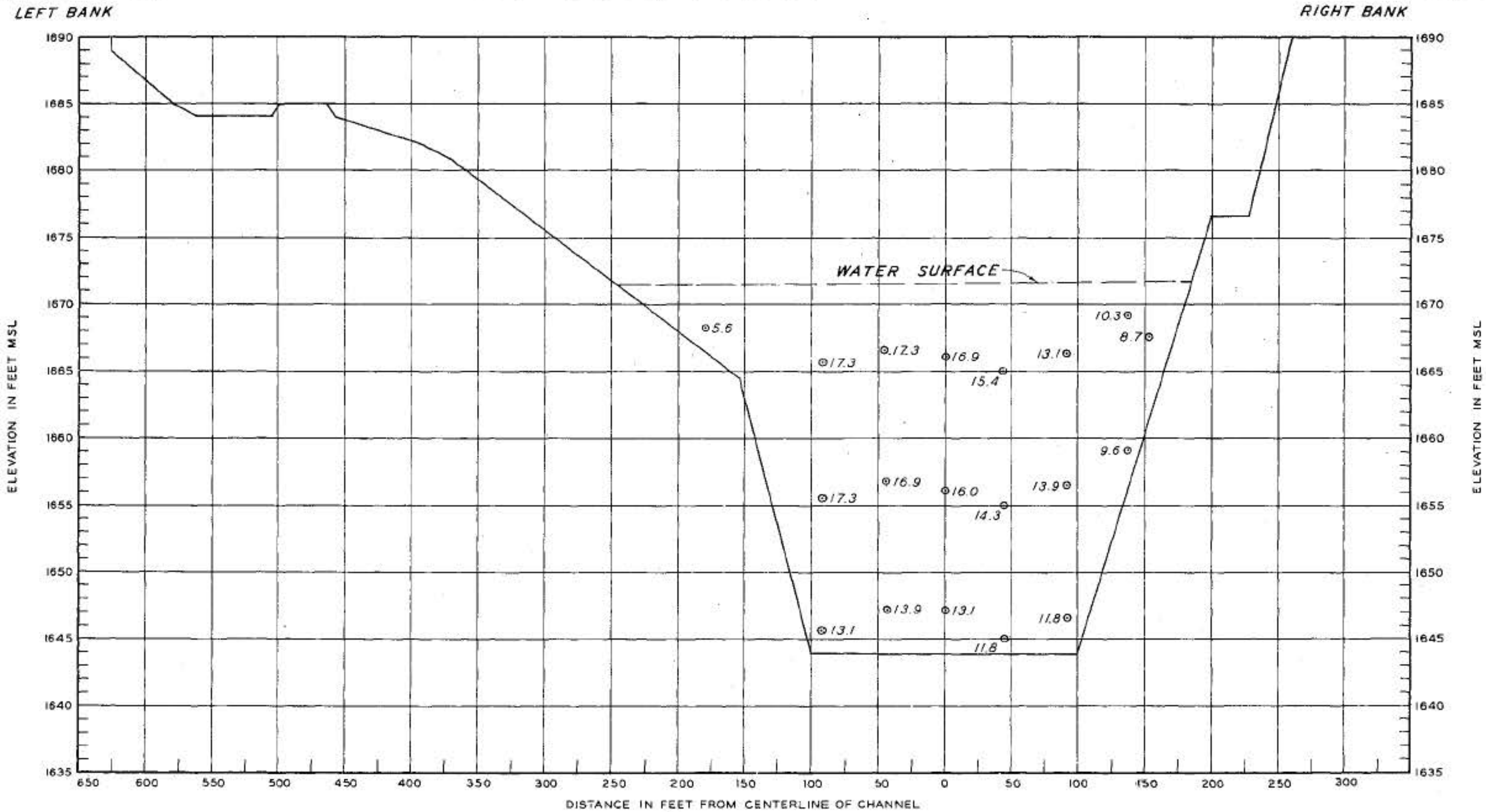
⊙16.4 PROTOTYPE VELOCITIES IN FEET PER SECOND.

VELOCITY DISTRIBUTION

TEST I

STATION 66+70 – RANGE 5

DISCHARGE: 86,000 CFS



LEGEND

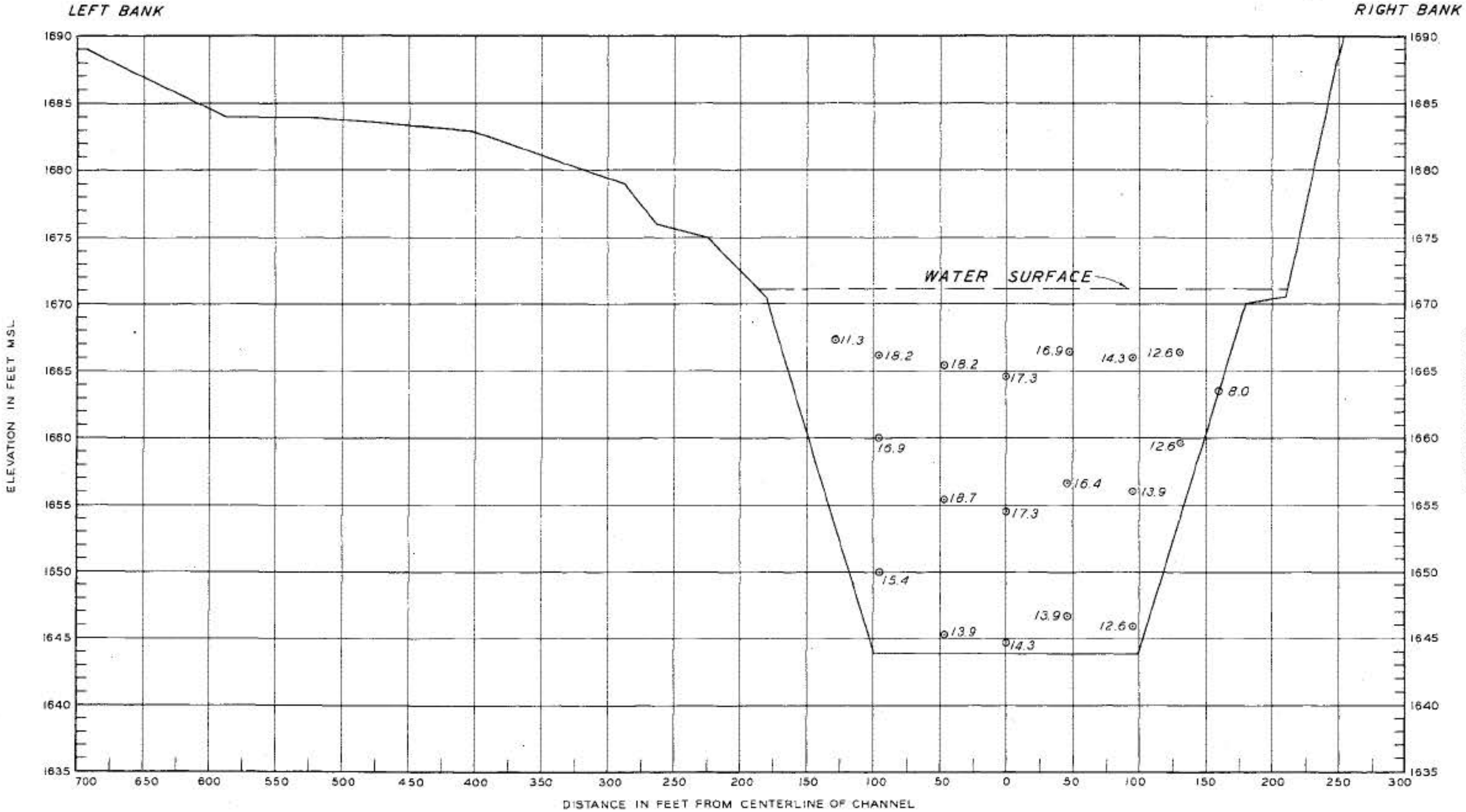
⊙16.4 PROTOTYPE VELOCITIES IN FEET PER SECOND.

VELOCITY DISTRIBUTION

TEST 1

STATION 57+90 - RANGE 6

DISCHARGE: 86,000 CFS



LEGEND

⊙16.4 PROTOTYPE VELOCITIES IN FEET PER SECOND.

VELOCITY DISTRIBUTION

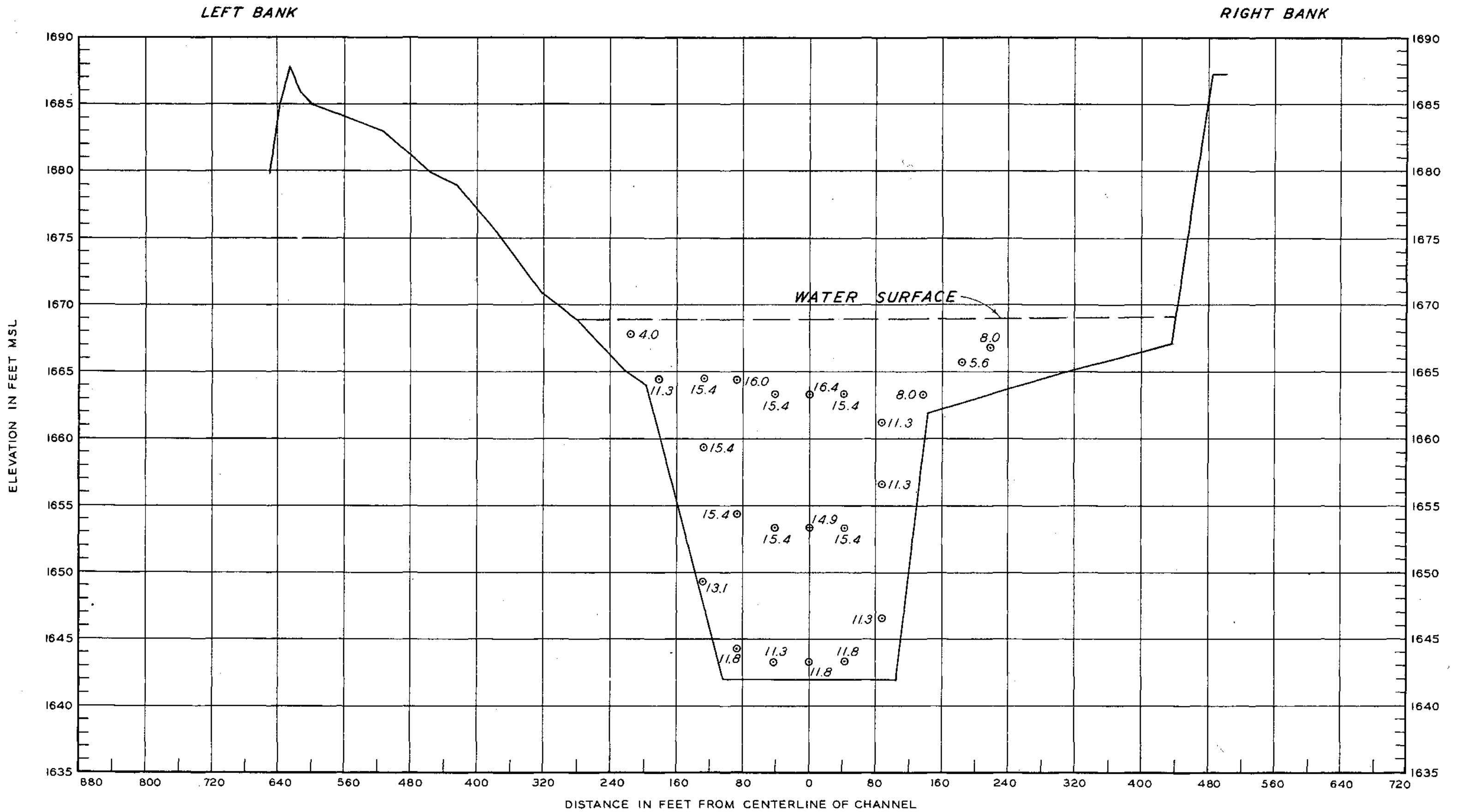
TEST I

STATION 55+76 - RANGE 7

DISCHARGE: 86,000 CFS

PLATE 8

PLATE 9



LEGEND

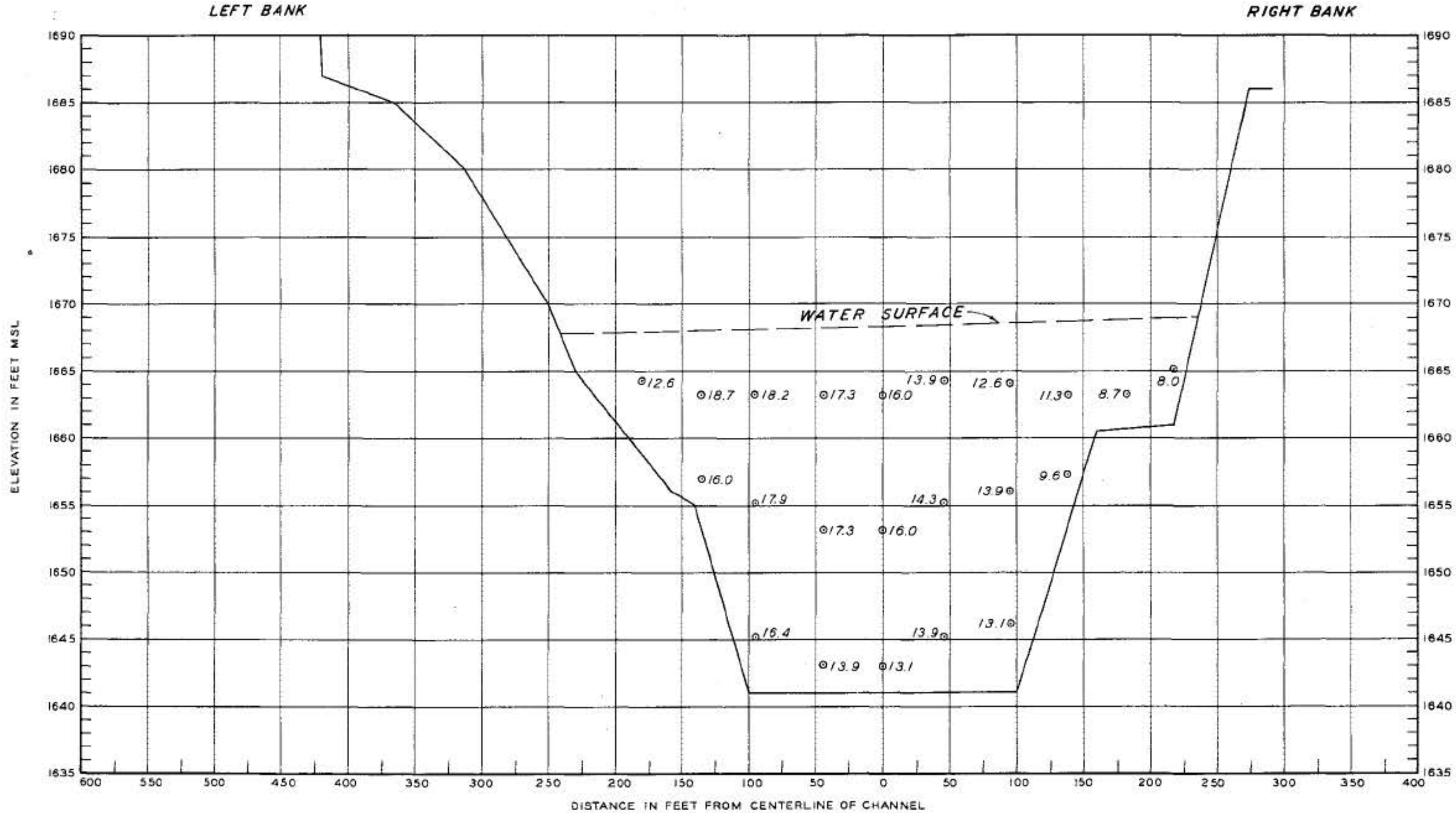
⊙16.4 PROTOTYPE VELOCITIES IN FEET PER SECOND.

VELOCITY DISTRIBUTION

TEST I

STATION 37+90 - RANGE 8

DISCHARGE: 86,000 CFS



LEGEND

○16.4 PROTOTYPE VELOCITIES IN FEET PER SECOND.

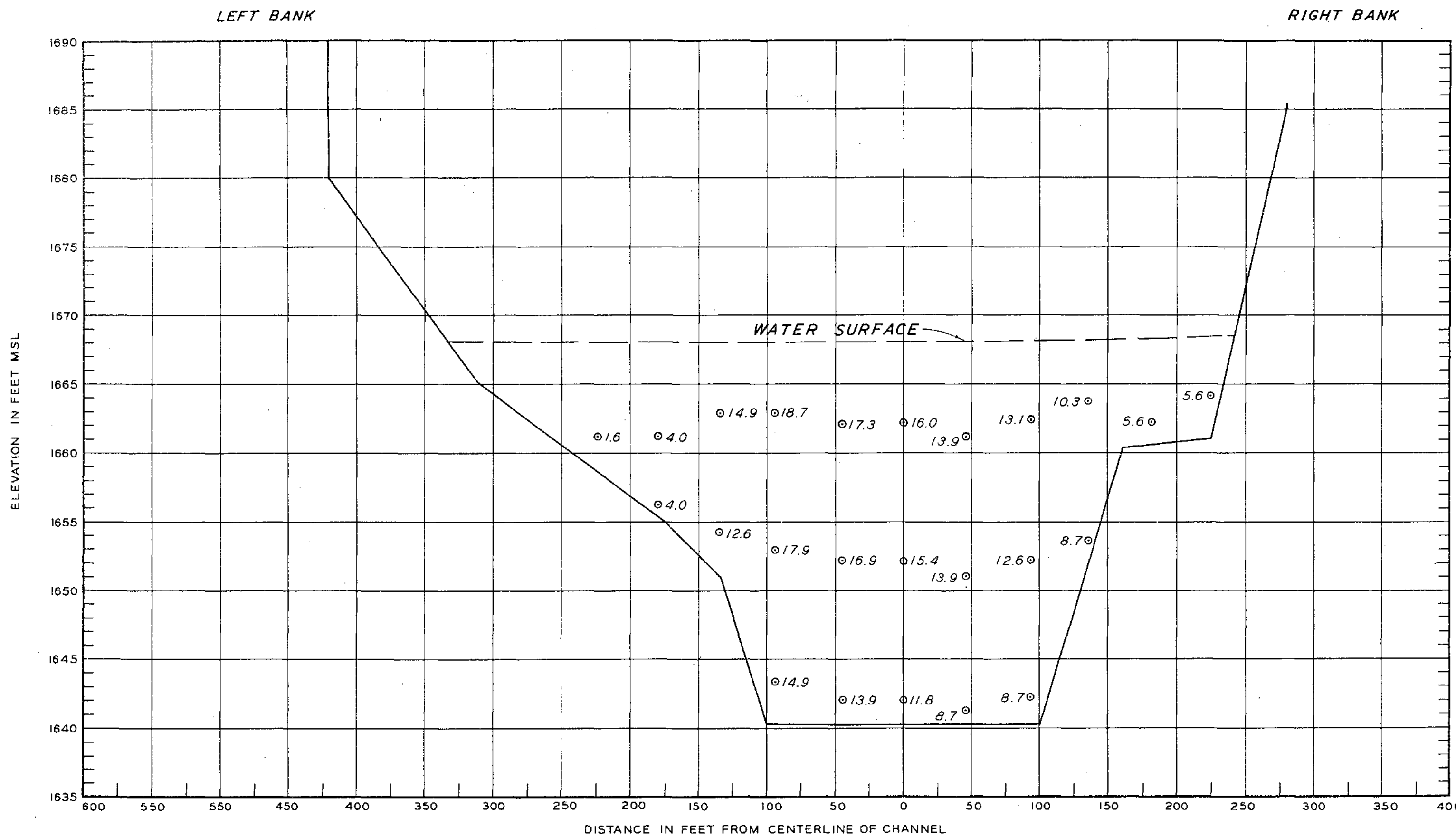
VELOCITY DISTRIBUTION

TEST I

STATION 29 + 00 - RANGE 9

DISCHARGE: 86,000 CFS

PLATE 11



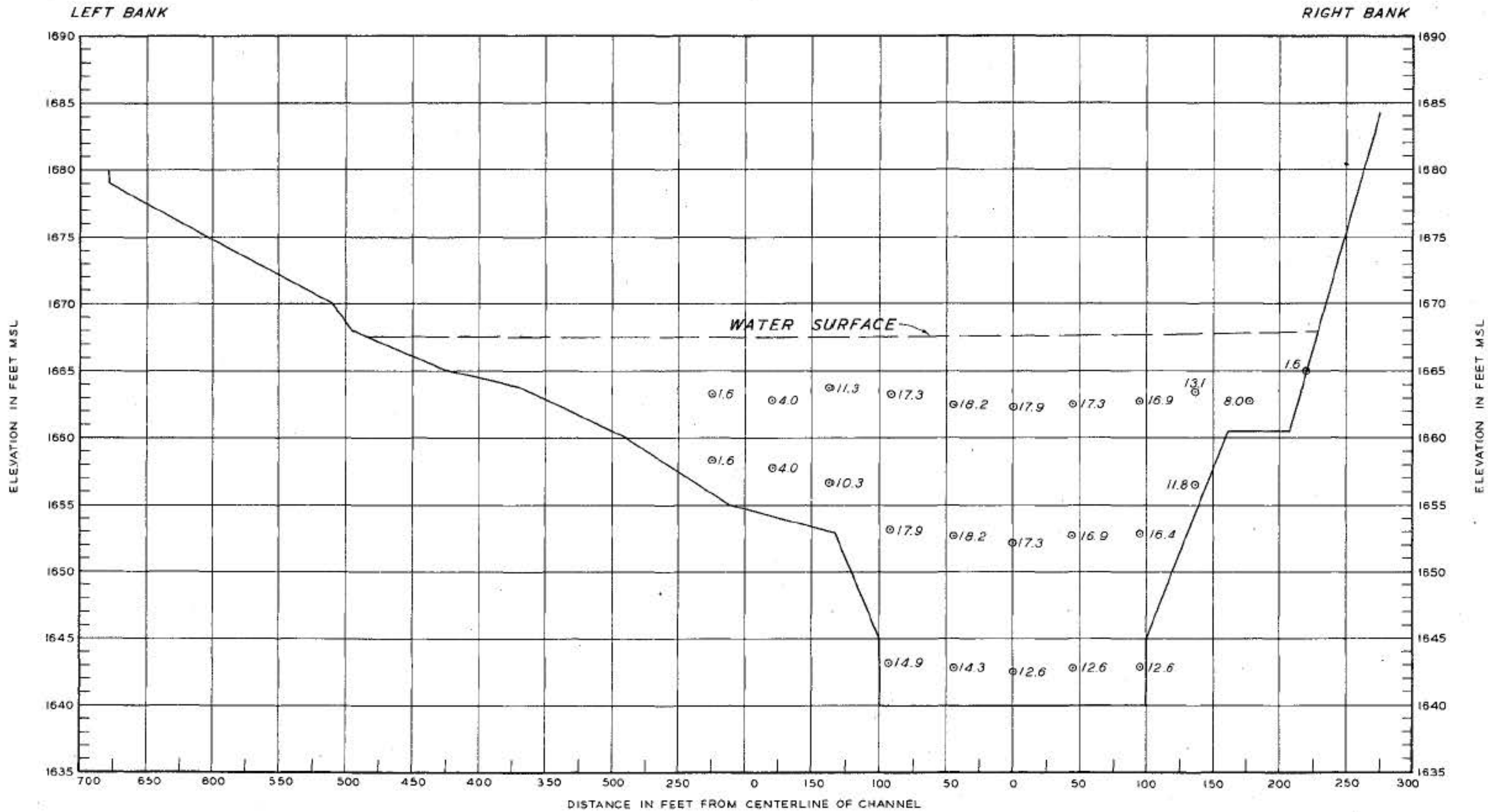
LEGEND

⊙16.4 PROTOTYPE VELOCITIES IN FEET PER SECOND.

VELOCITY DISTRIBUTION

TEST I

STATION 24+57 - RANGE 10
DISCHARGE: 86,000 CFS



LEGEND

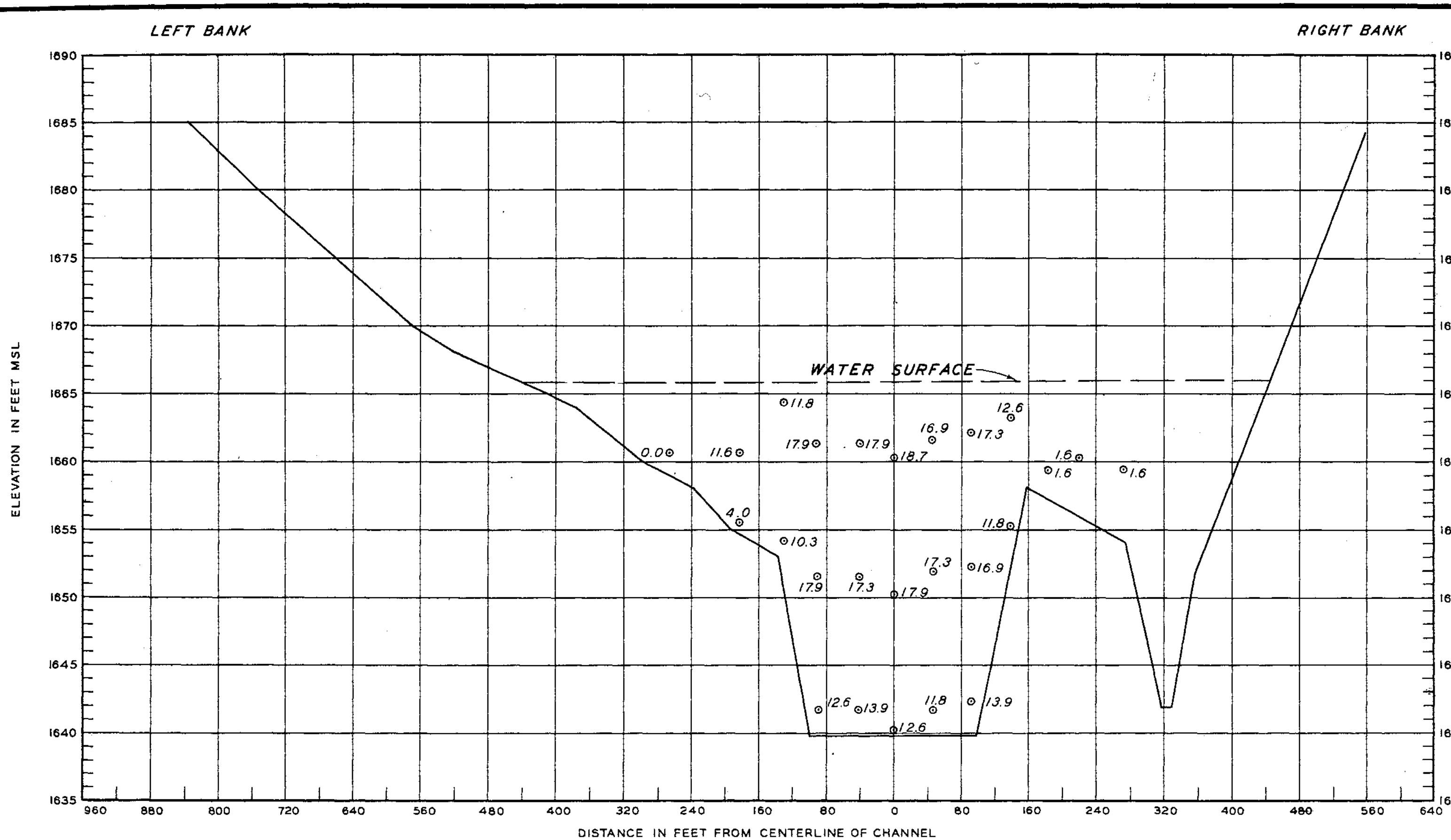
⊙16.4 PROTOTYPE VELOCITIES IN FEET PER SECOND.

VELOCITY DISTRIBUTION

TEST I

STATION 19+25 - RANGE 11
DISCHARGE: 86,000 CFS

PLATE 13



LEGEND

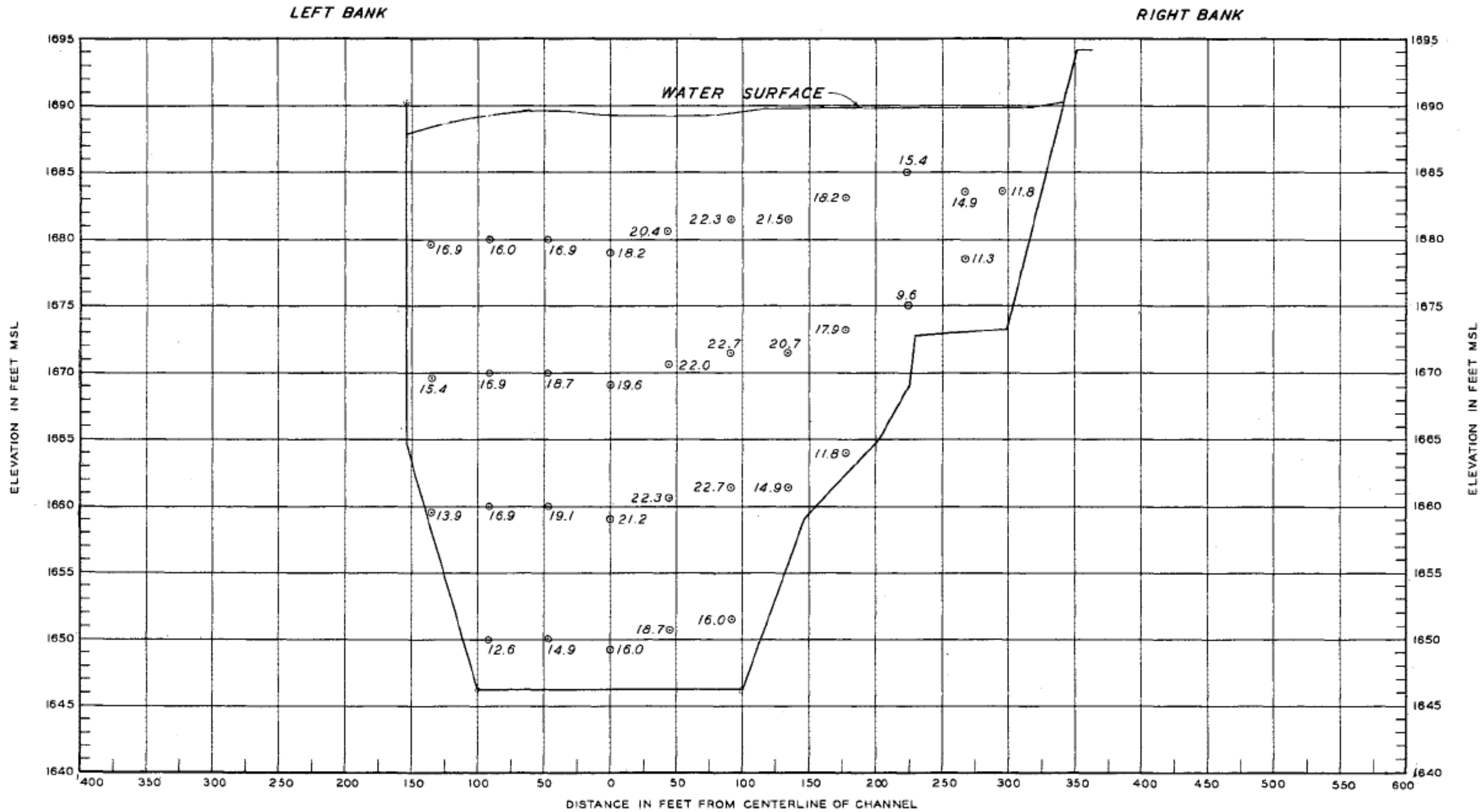
⊙16.4 PROTOTYPE VELOCITIES IN FEET PER SECOND.

VELOCITY DISTRIBUTION

TEST I

STATION 17 + 78-RANGE 12

DISCHARGE: 86,000 CFS



LEGEND

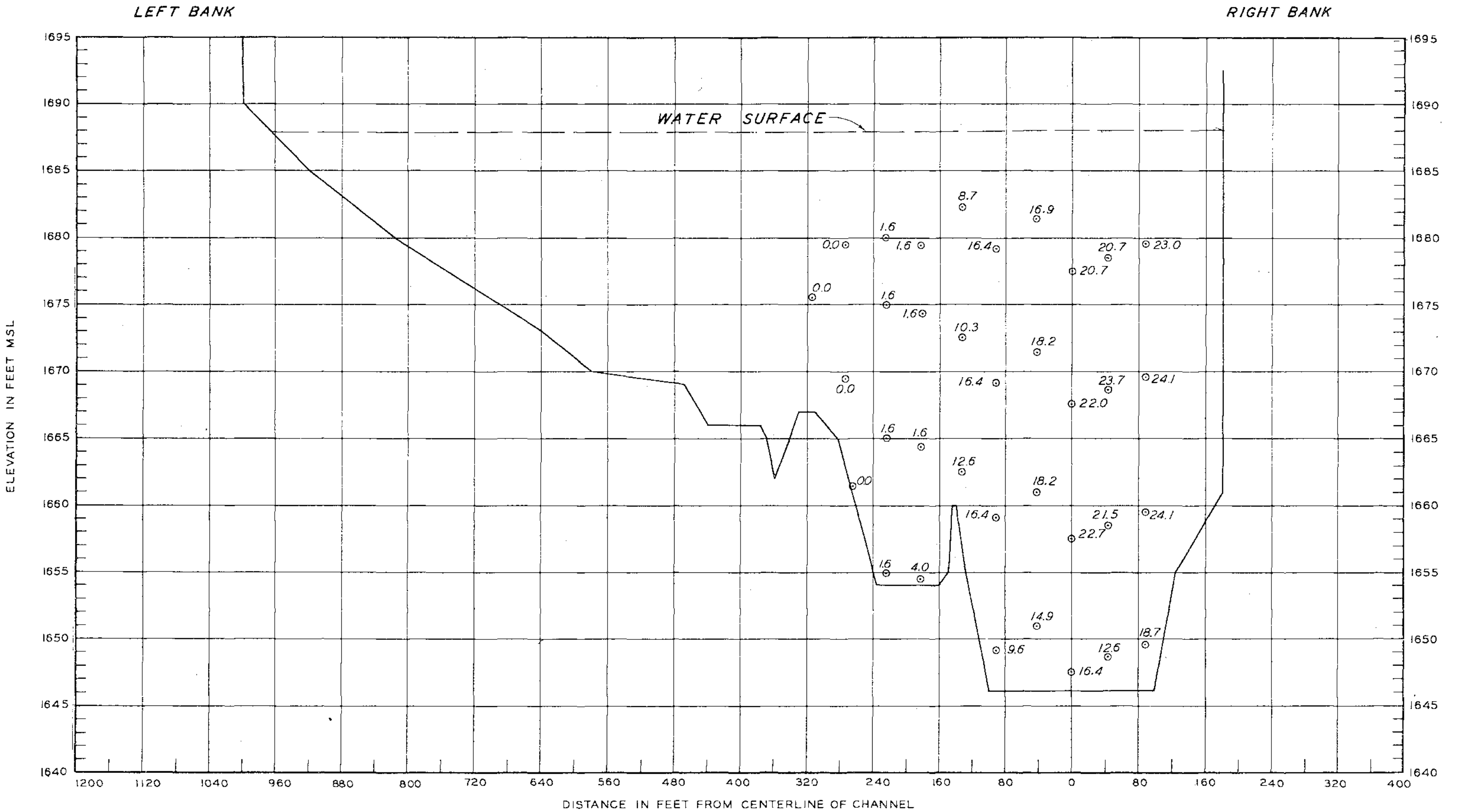
⊙16.4 PROTOTYPE VELOCITIES IN FEET PER SECOND.

VELOCITY DISTRIBUTION

TEST I

STATION 82 + 22-RANGE I

DISCHARGE: 206,000 CFS



LEGEND

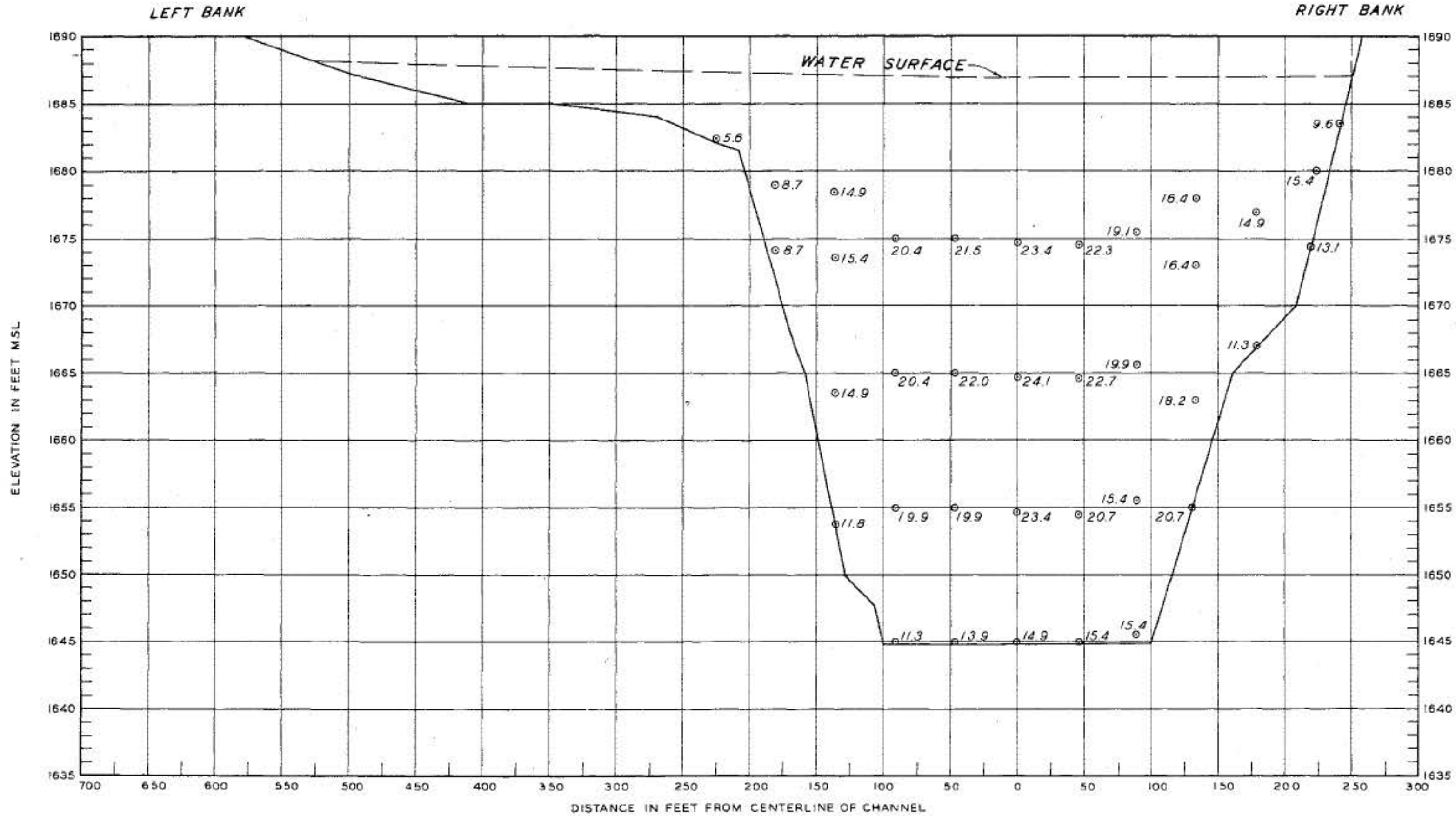
⊙16.4 PROTOTYPE VELOCITIES IN FEET PER SECOND.

VELOCITY DISTRIBUTION

TEST I

STATION 80 + 13-RANGE 2

DISCHARGE: 206,000 CFS



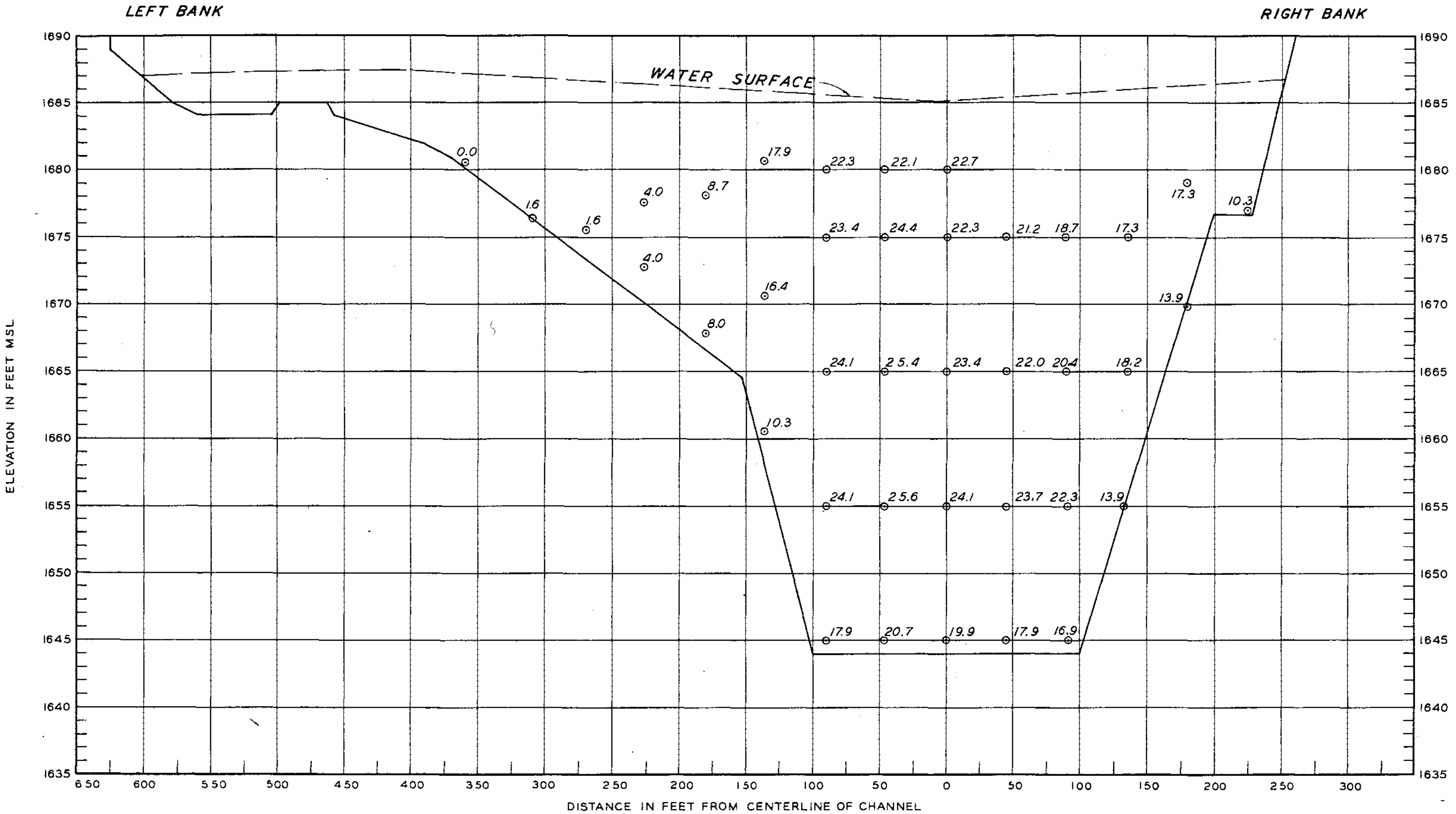
LEGEND

⊙16.4 PROTOTYPE VELOCITIES IN FEET PER SECOND.

VELOCITY DISTRIBUTION

TEST I

STATION 66+70 – RANGE 5
DISCHARGE: 206,000 CFS



LEGEND

⊙16.4 PROTOTYPE VELOCITIES IN FEET PER SECOND.

VELOCITY DISTRIBUTION

TEST I

STATION 57 + 90–RANGE 6

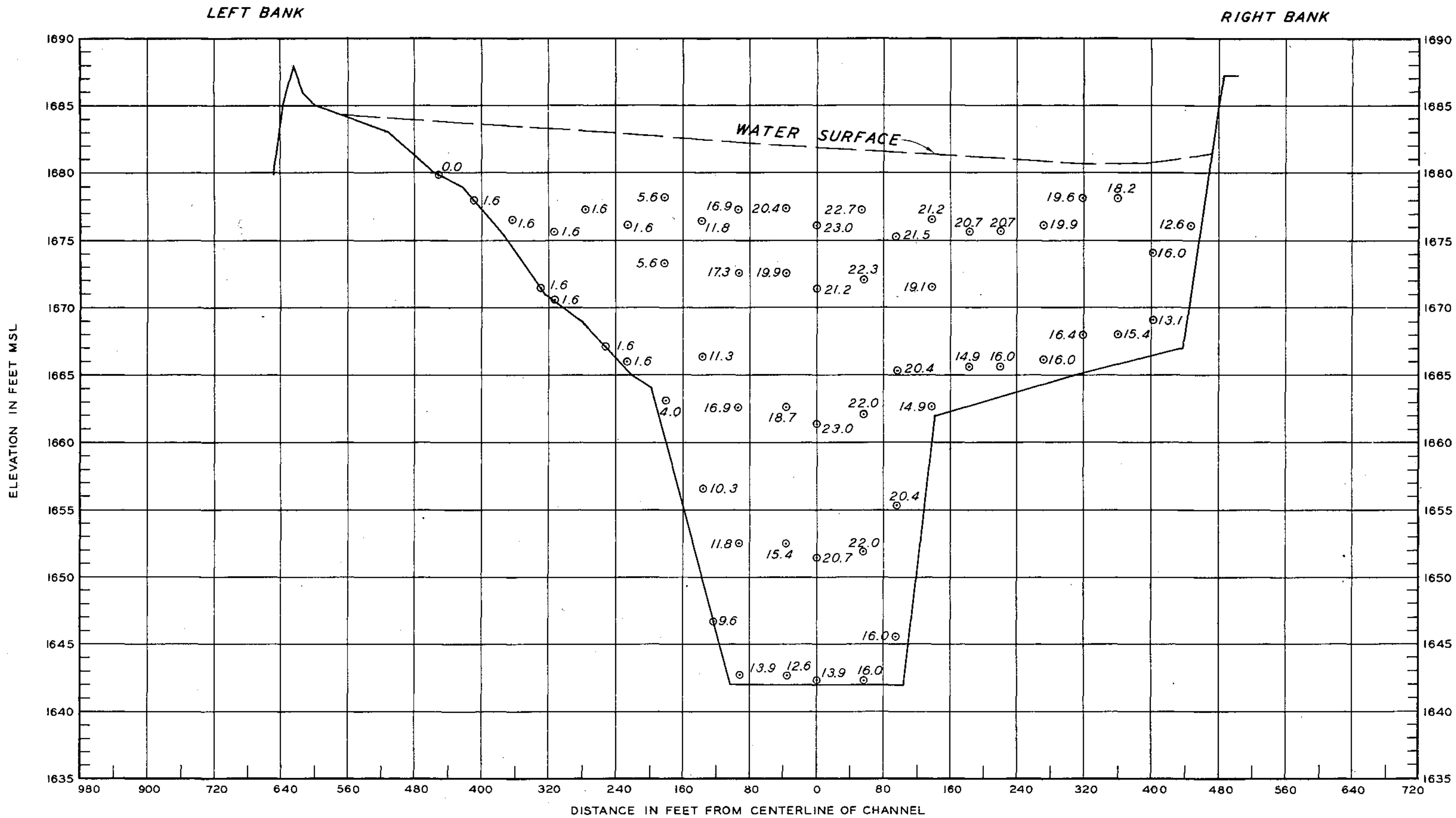
DISCHARGE: 206,000 CFS

VELOCITY DISTRIBUTION

TEST I

STATION 55 + 76-RANGE 7

DISCHARGE: 206,000 CFS



LEGEND

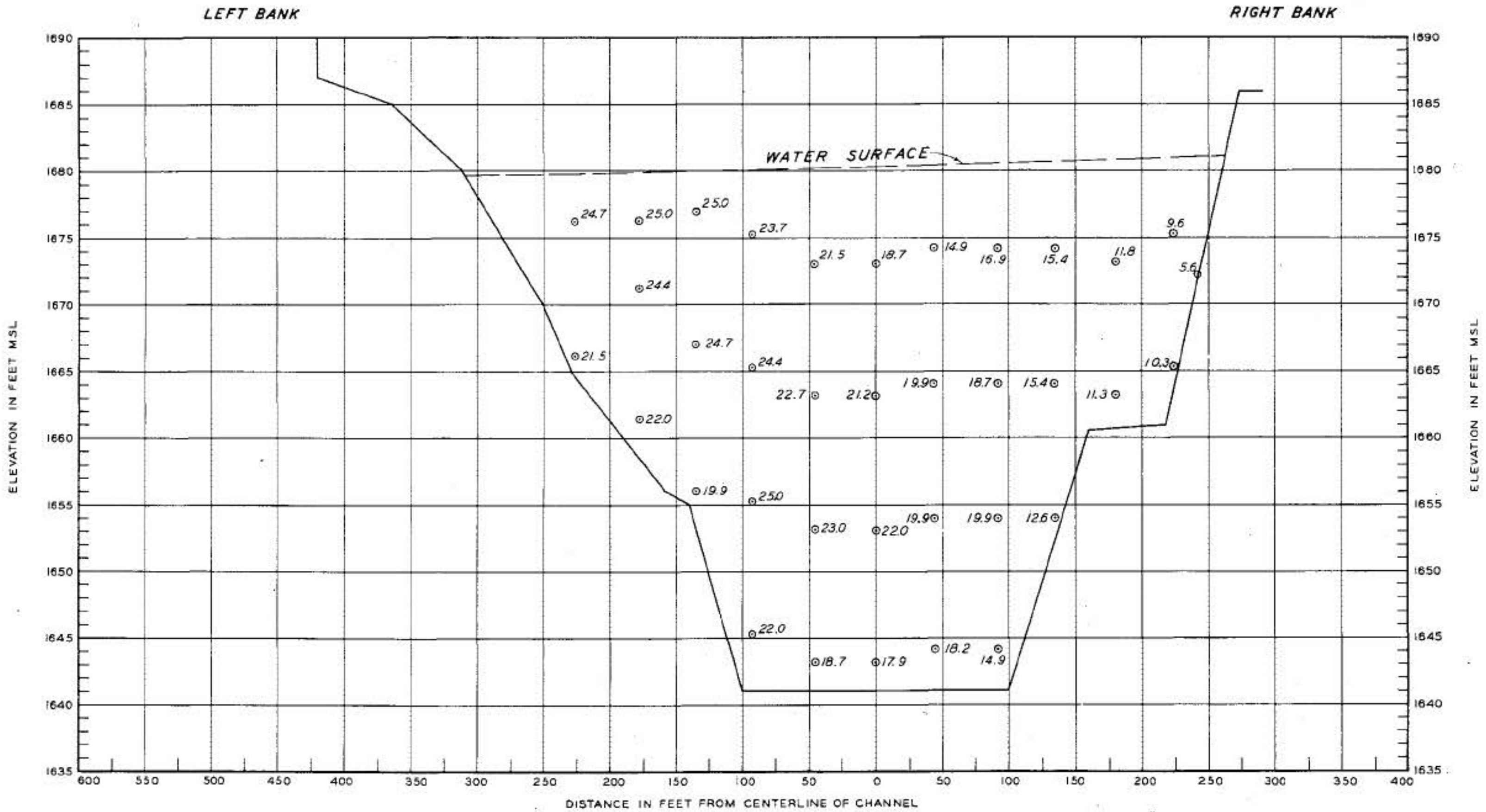
⊙16.4 PROTOTYPE VELOCITIES IN FEET PER SECOND.

VELOCITY DISTRIBUTION

TEST I

STATION 37+90 - RANGE 8

DISCHARGE: 206,000 CFS



LEGEND

⊙16.4 PROTOTYPE VELOCITIES IN FEET PER SECOND.

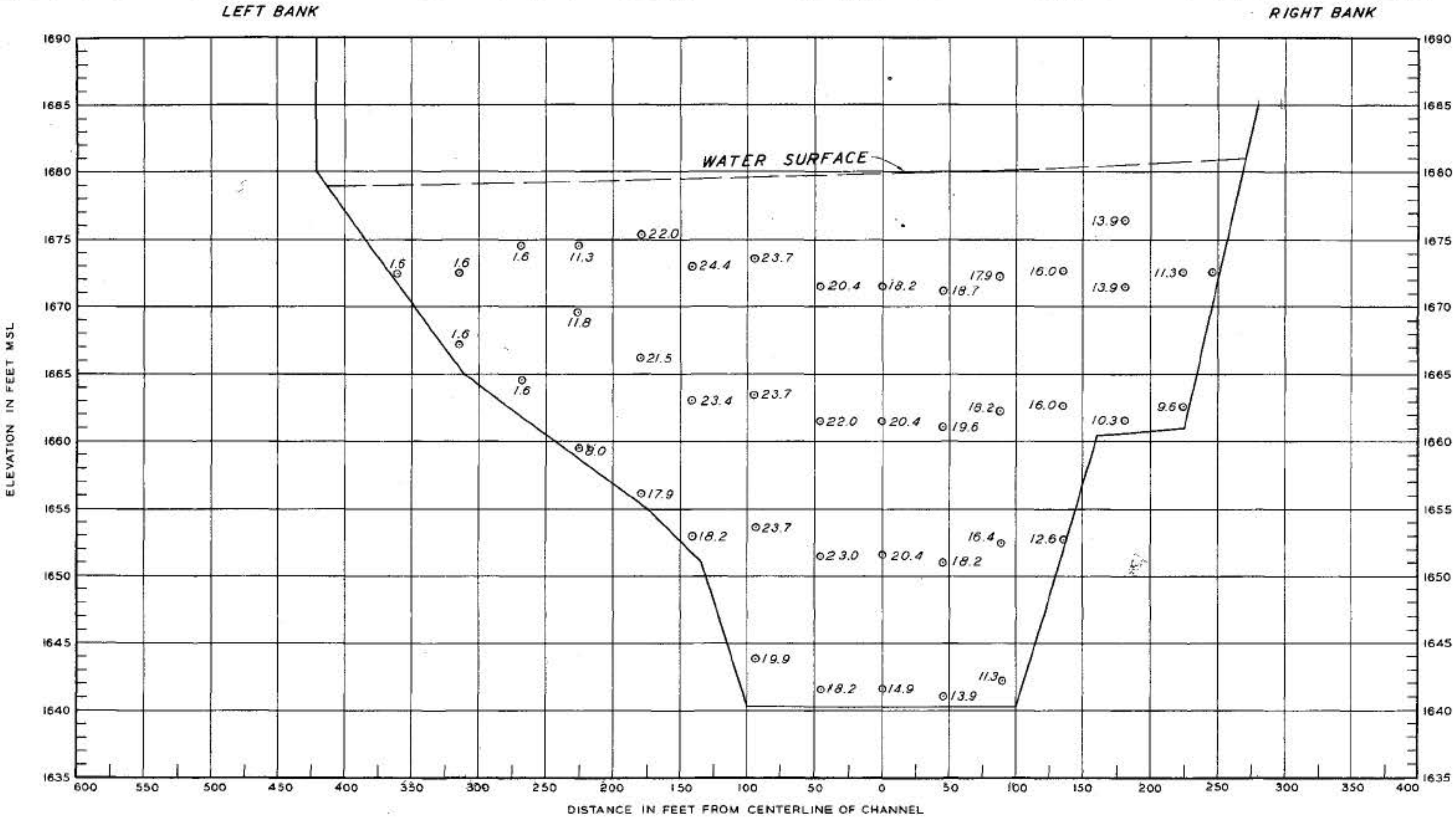
VELOCITY DISTRIBUTION

TEST I

STATION 29+00 – RANGE 9

DISCHARGE: 206,000 CFS

PLATE 21



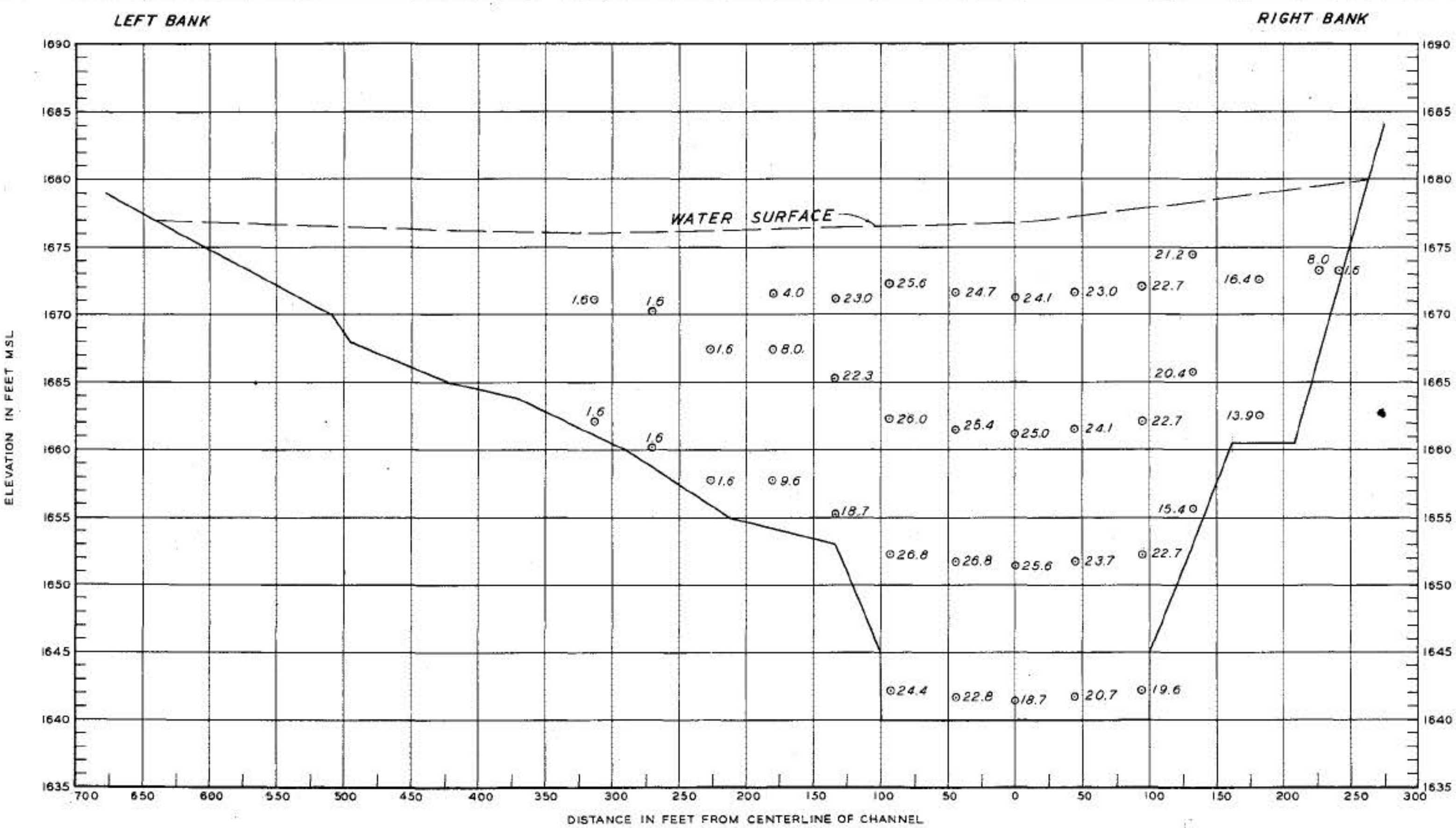
LEGEND

⊙16.4 PROTOTYPE VELOCITIES IN FEET PER SECOND.

VELOCITY DISTRIBUTION

TEST I

STATION 24 + 57-RANGE 10
DISCHARGE: 206,000 CFS



LEGEND

○16.4 PROTOTYPE VELOCITIES IN FEET PER SECOND.

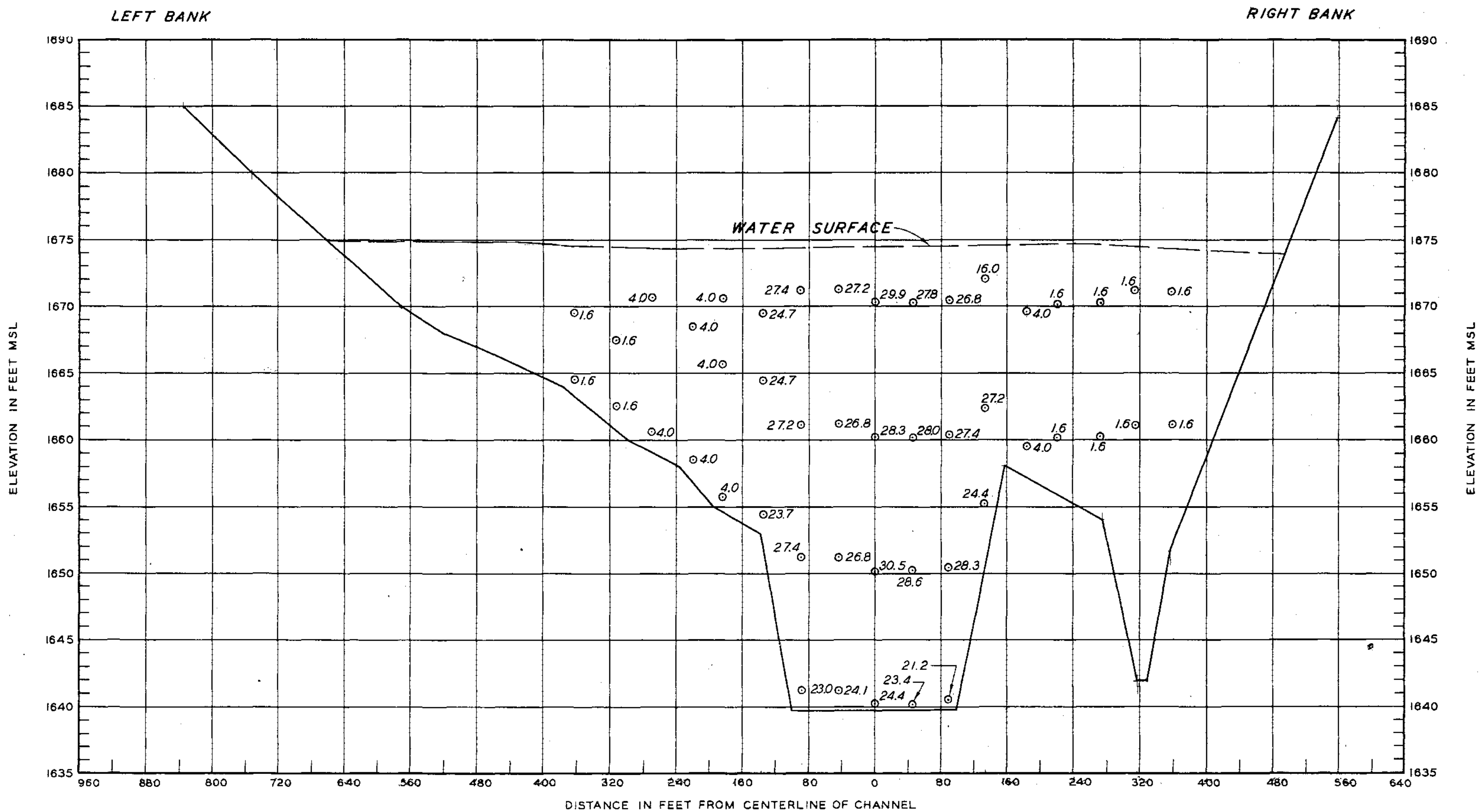
VELOCITY DISTRIBUTION

TEST I

STATION 19+25 - RANGE 11

DISCHARGE: 206,000 CFS

PLATE 23



LEGEND

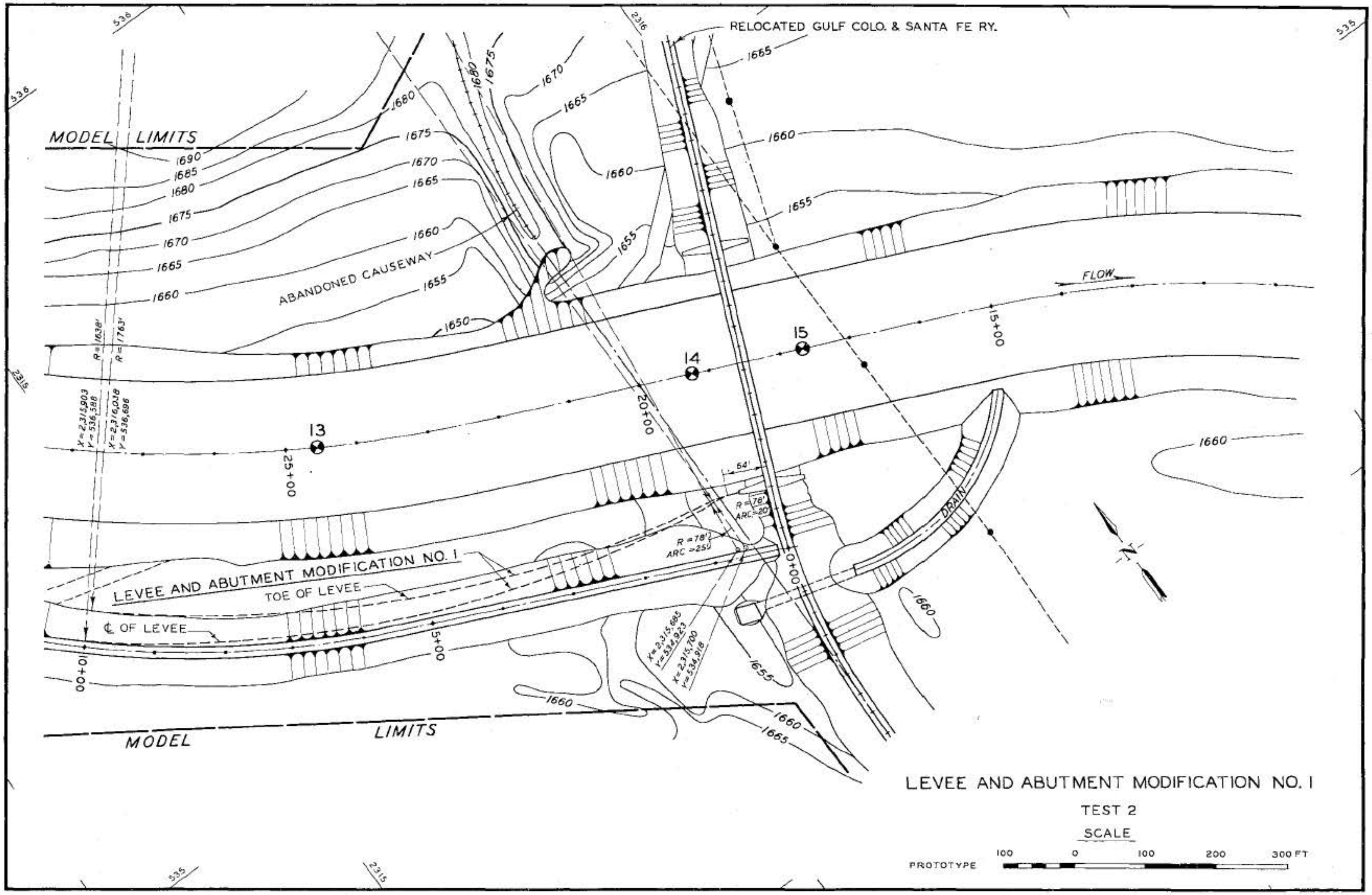
⊙16.4 PROTOTYPE VELOCITIES IN FEET PER SECOND.

VELOCITY DISTRIBUTION

TEST 1

STATION 17 + 78 - RANGE 12

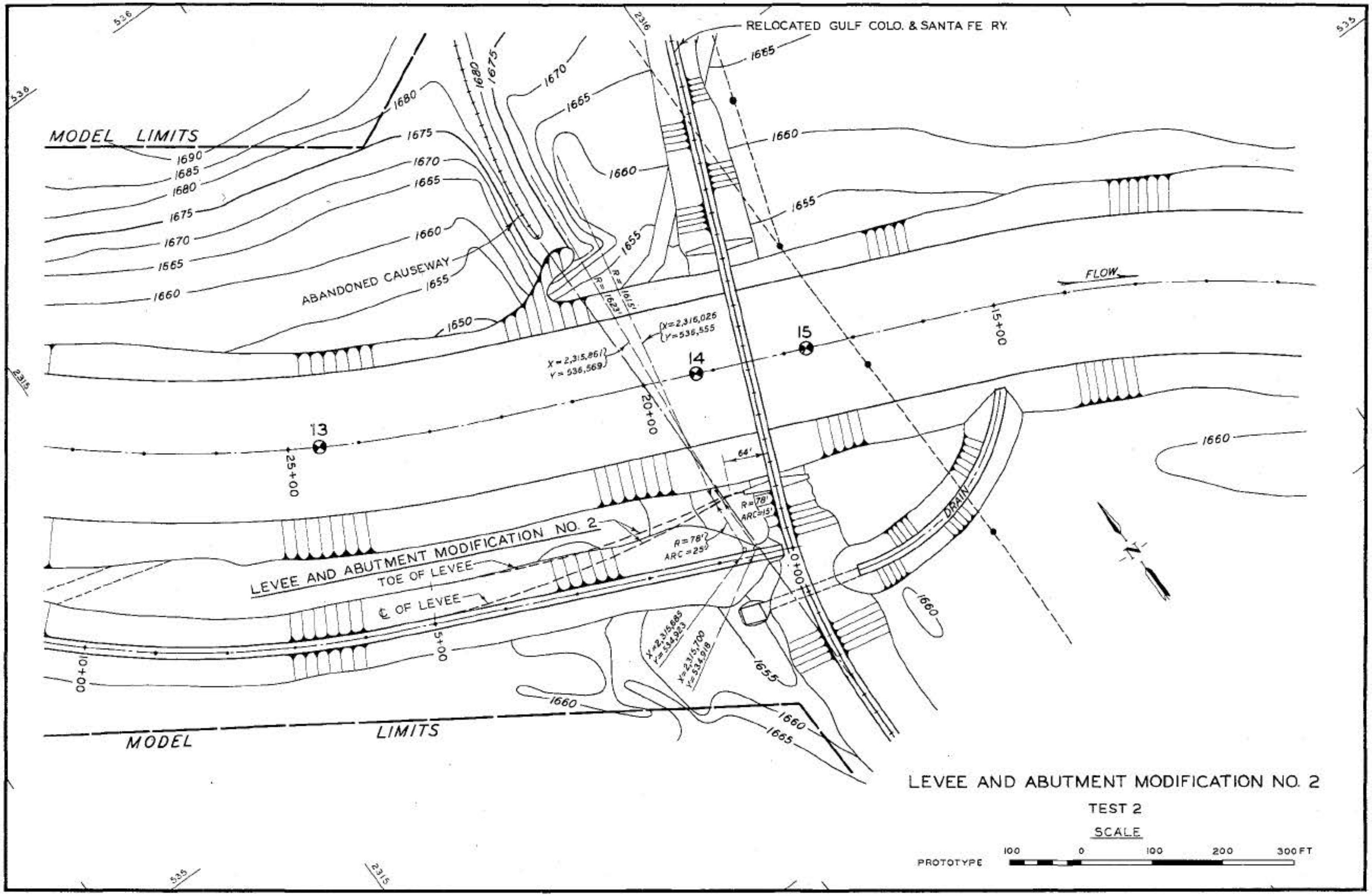
DISCHARGE: 206,000 CFS



LEVEE AND ABUTMENT MODIFICATION NO. 1

TEST 2

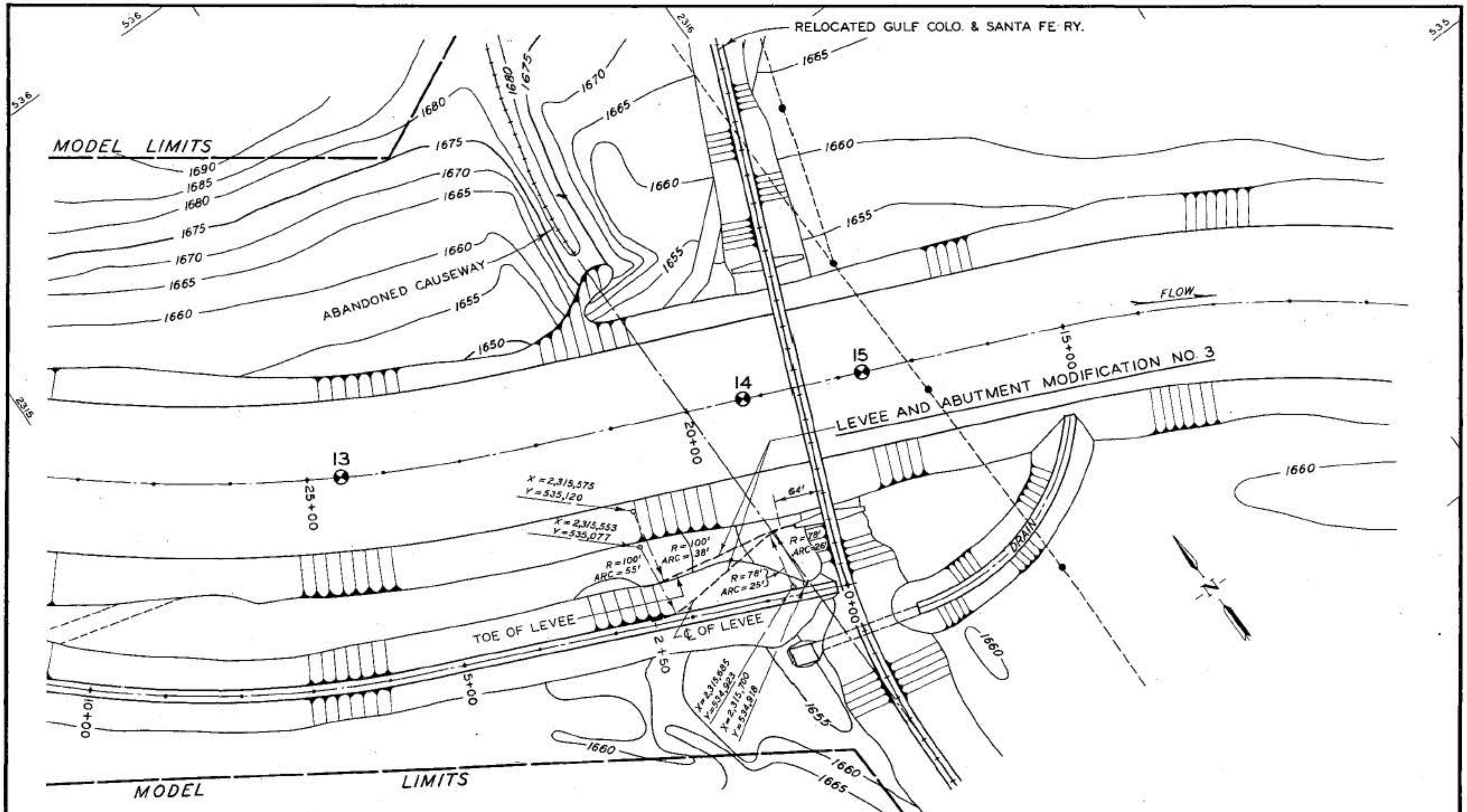
PLATE 24



LEVEE AND ABUTMENT MODIFICATION NO. 2

TEST 2

SCALE



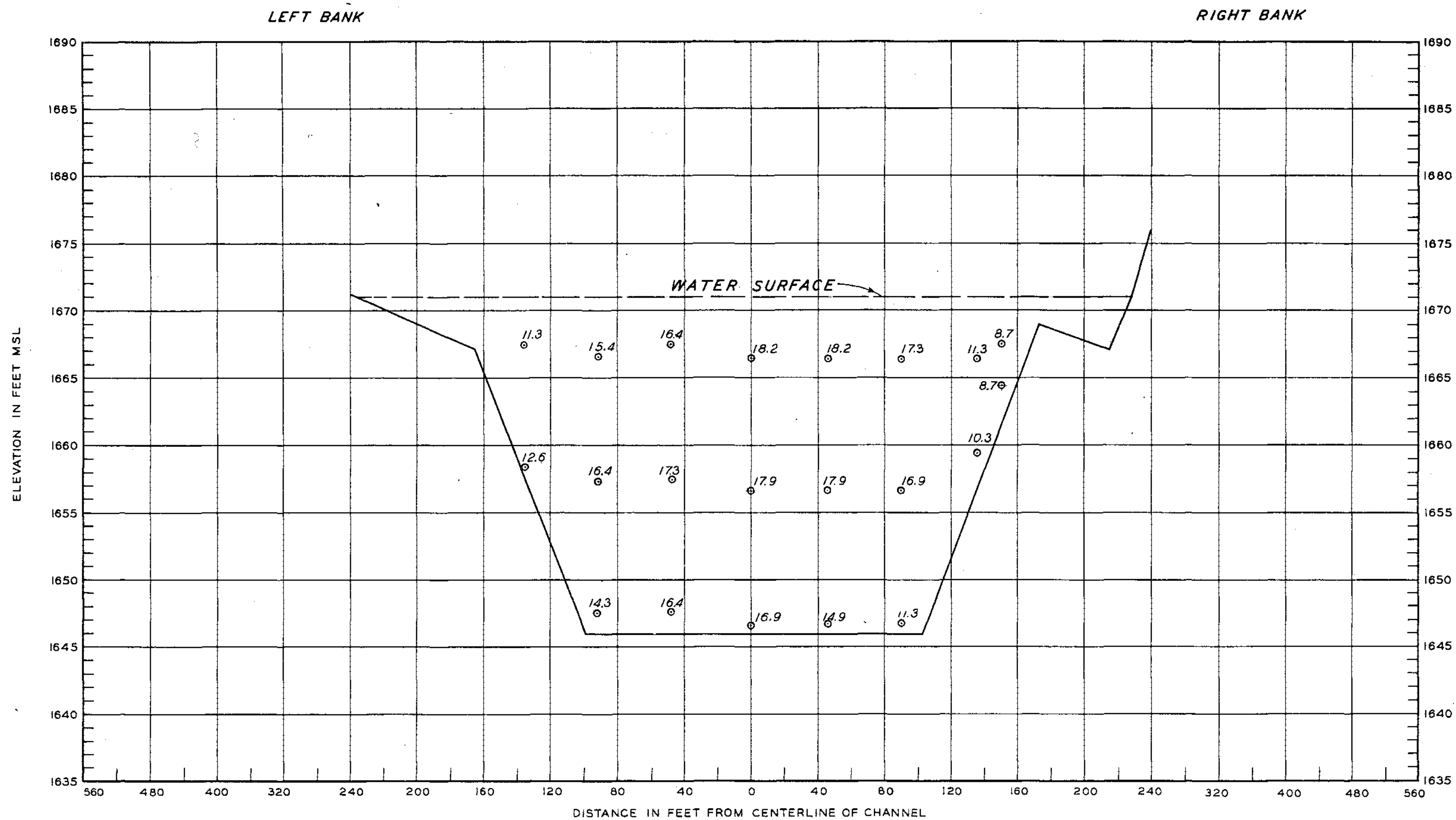
LEVEE AND ABUTMENT MODIFICATION NO. 3

TEST 2

SCALE

PROTOTYPE 100 0 100 200 300 FT

PLATE 26



LEGEND

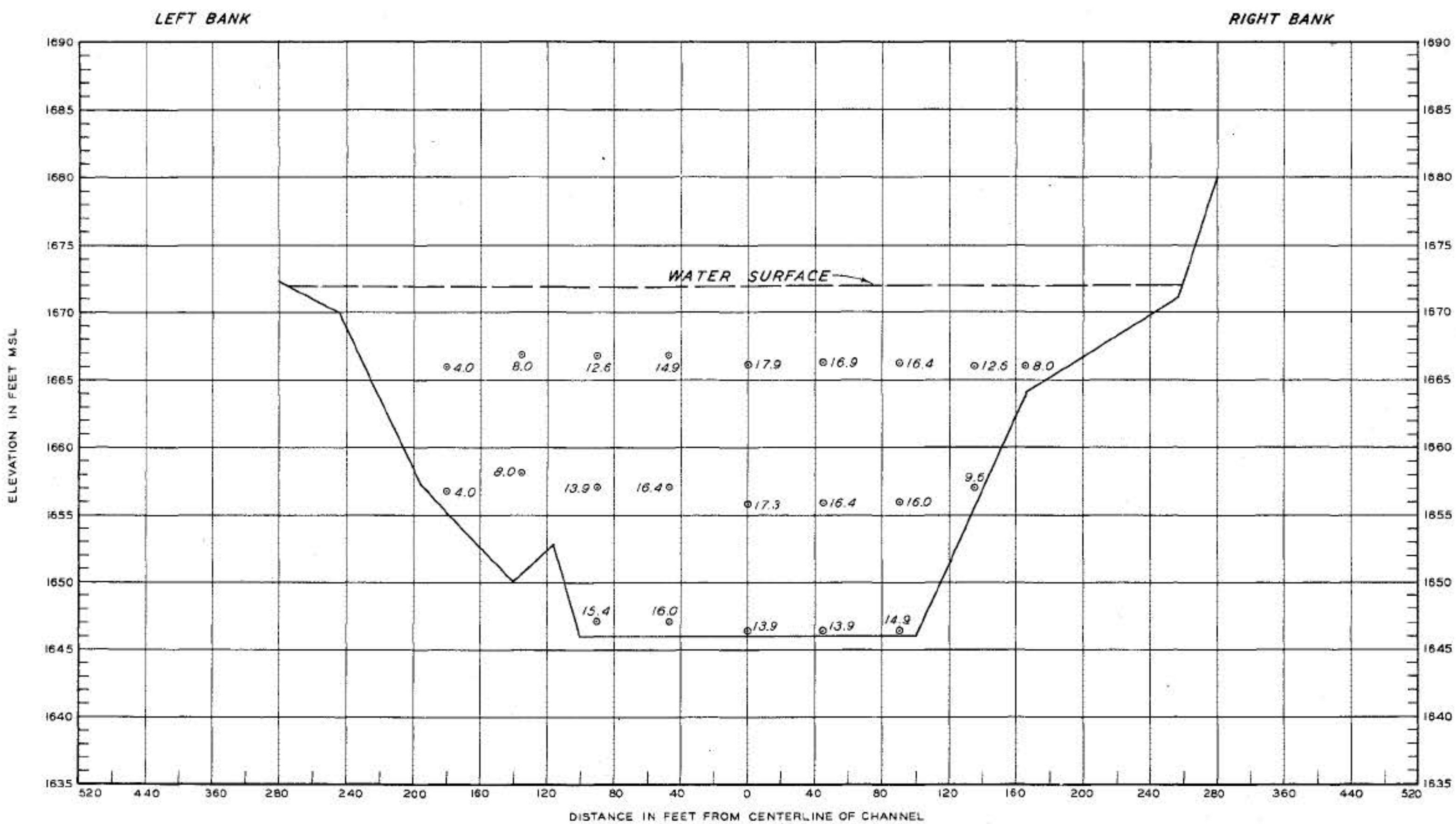
⊙16.4 PROTOTYPE VELOCITIES IN FEET PER SECOND.

VELOCITY DISTRIBUTION

TEST 5

STATION 74 + 43 – RANGE 3

DISCHARGE { BRADY CREEK 50,000 CFS
LIVE OAK CREEK 25,000 CFS



LEGEND

⊙16.4 PROTOTYPE VELOCITIES IN FEET PER SECOND.

VELOCITY DISTRIBUTION

TEST 5

STATION 77 + 43 - RANGE 4

DISCHARGE { BRADY CREEK 50,000 CFS
LIVE OAK CREEK 25,000 CFS